ES ELECTRONIC SYSTEMS

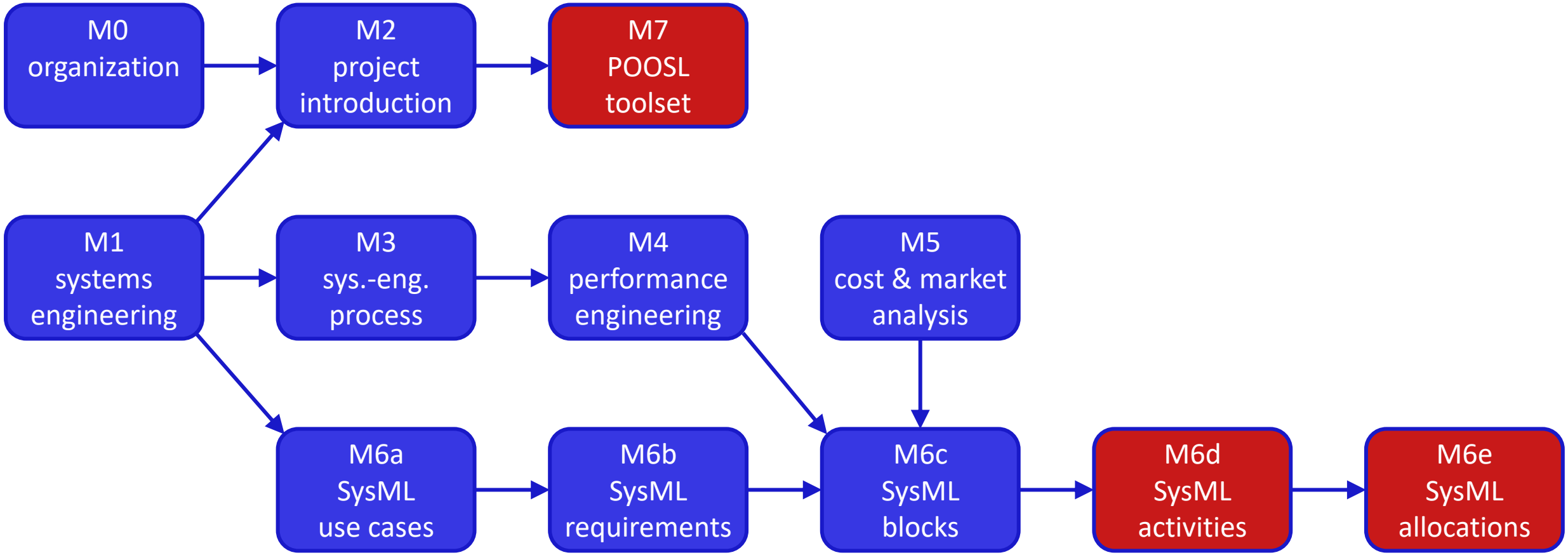
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

5XIC0 Electronic-Systems Engineering

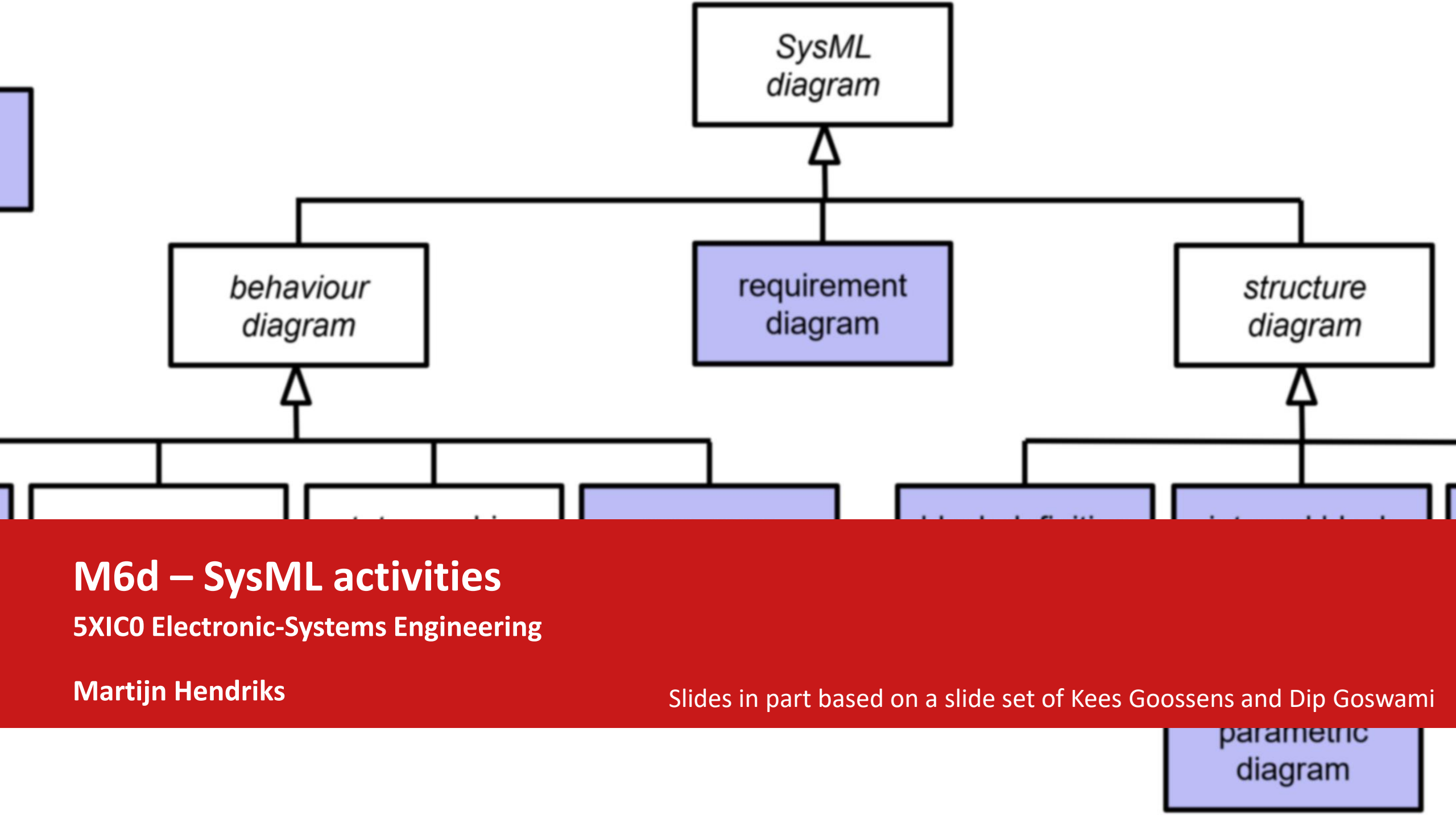
Twan Basten, Martijn Hendriks

Electrical Engineering

modules



ES ELECTRONIC SYSTEMS TU/e



M6d – SysML activities

5XIC0 Electronic-Systems Engineering

Martijn Hendriks

Slides in part based on a slide set of Kees Goossens and Dip Goswami

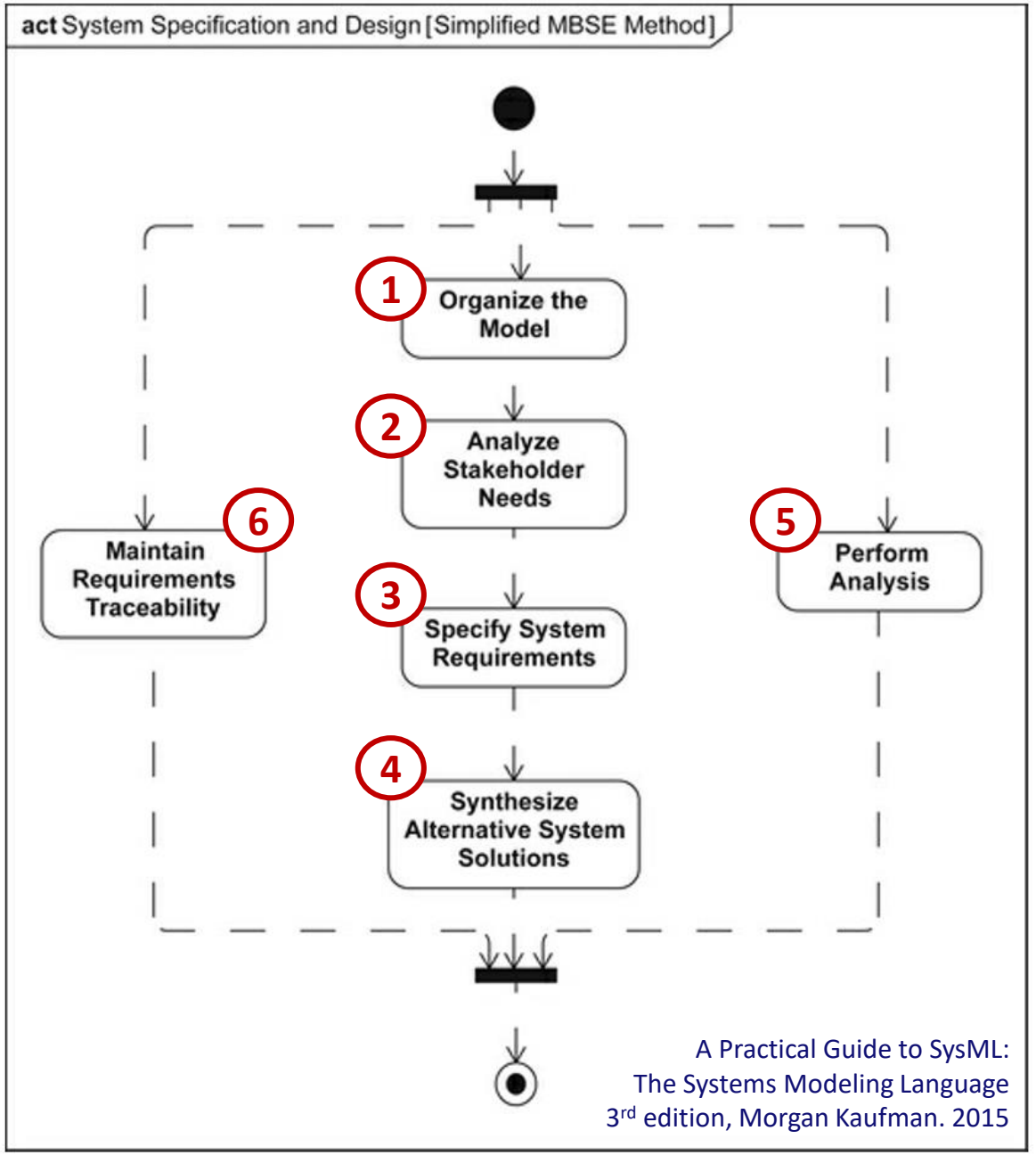
in this lecture

SysML activities

- model elements
- activity diagram

a simplified² MBSE method

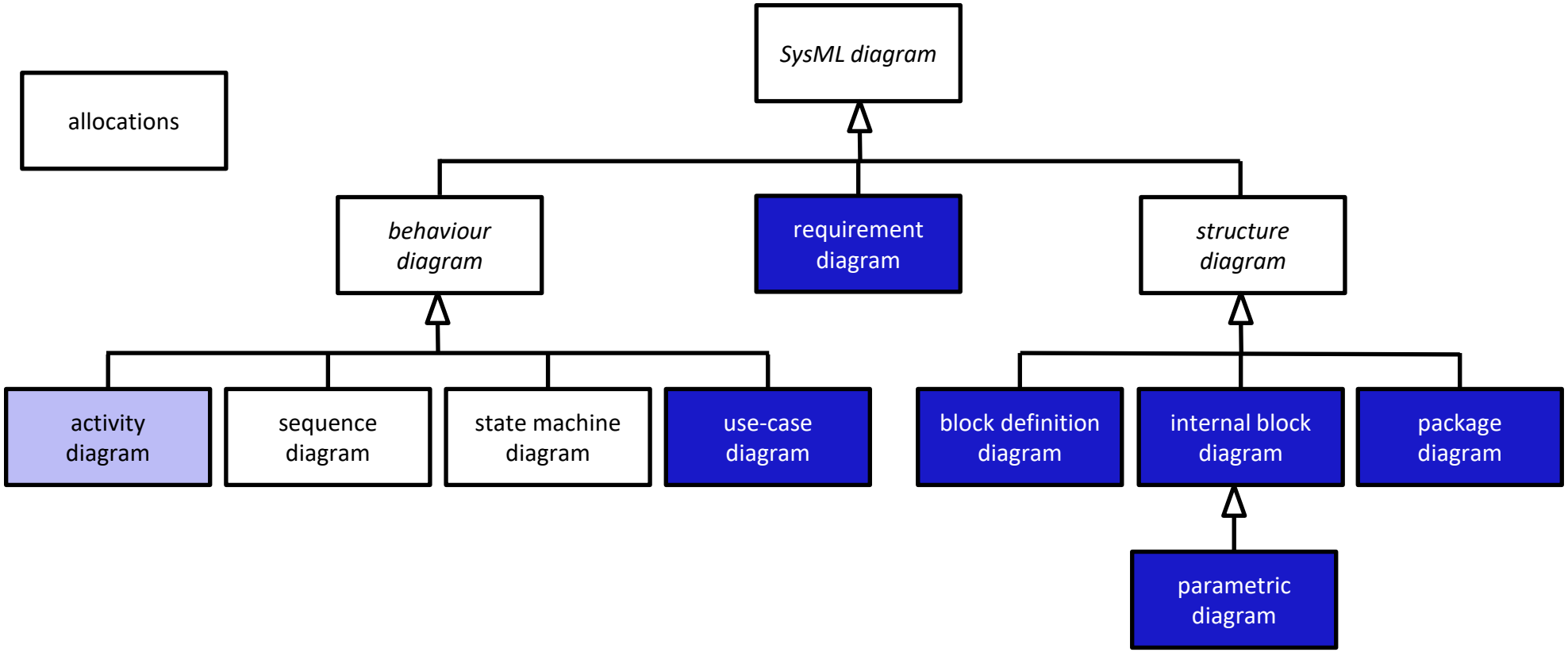
1. SysML package diagram
2. stakeholders
   SysML UC diagrams, UC descriptions
   measures of effectiveness (moes)
3. SysML requirement diagrams
4. create multiple alternatives
   - SysML BDDs – system decomposition
   - SysML IBDs – interconnections
   - **SysML Activity diagrams – UC refinements**
   - SysML Allocations – activities to blocks
5. - SysML PAR diagrams – covering all moes
   - POOSL models – makespan
   - analytical model – profit
   - verification
6. - SysML Allocation – reqs to blocks/activities



A Practical Guide to SysML:
The Systems Modeling Language
3rd edition, Morgan Kaufman. 2015

SysML – diagram overview

diagrams are **views** on the model
(i.e., on a subset of model elements)



SysML – activities – purpose

system structure can be modeled with blocks

- logical structure
- physical structure
- decomposition

=> static view

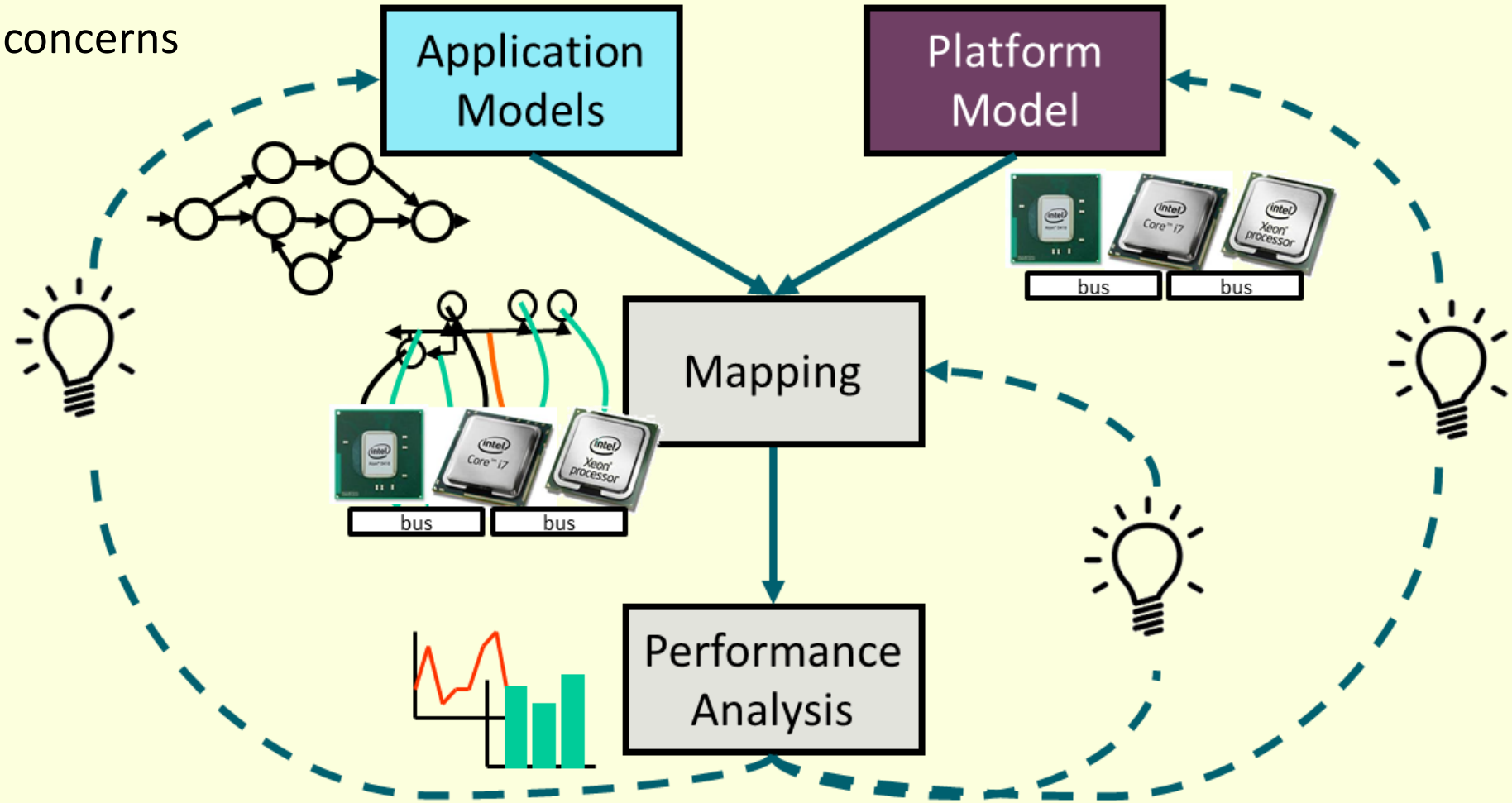
system behavior can be modeled with activities

- sequential/parallel and conditional execution of actions
- decomposition

=> dynamic view

Y-chart

- separation of concerns
- model reuse



source: Kienhuis et al. ASAP 1997

a simplified² MBSE method

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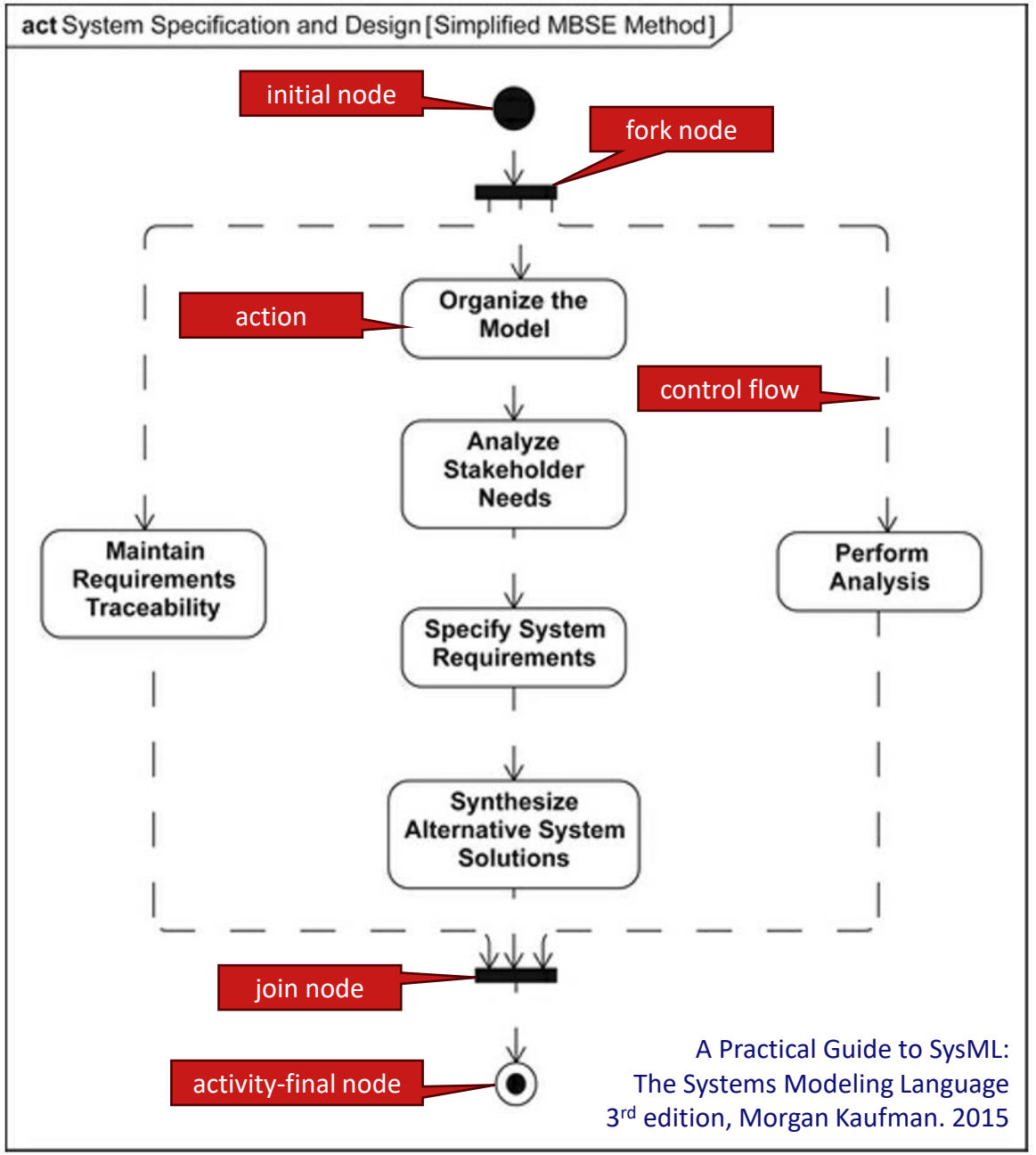

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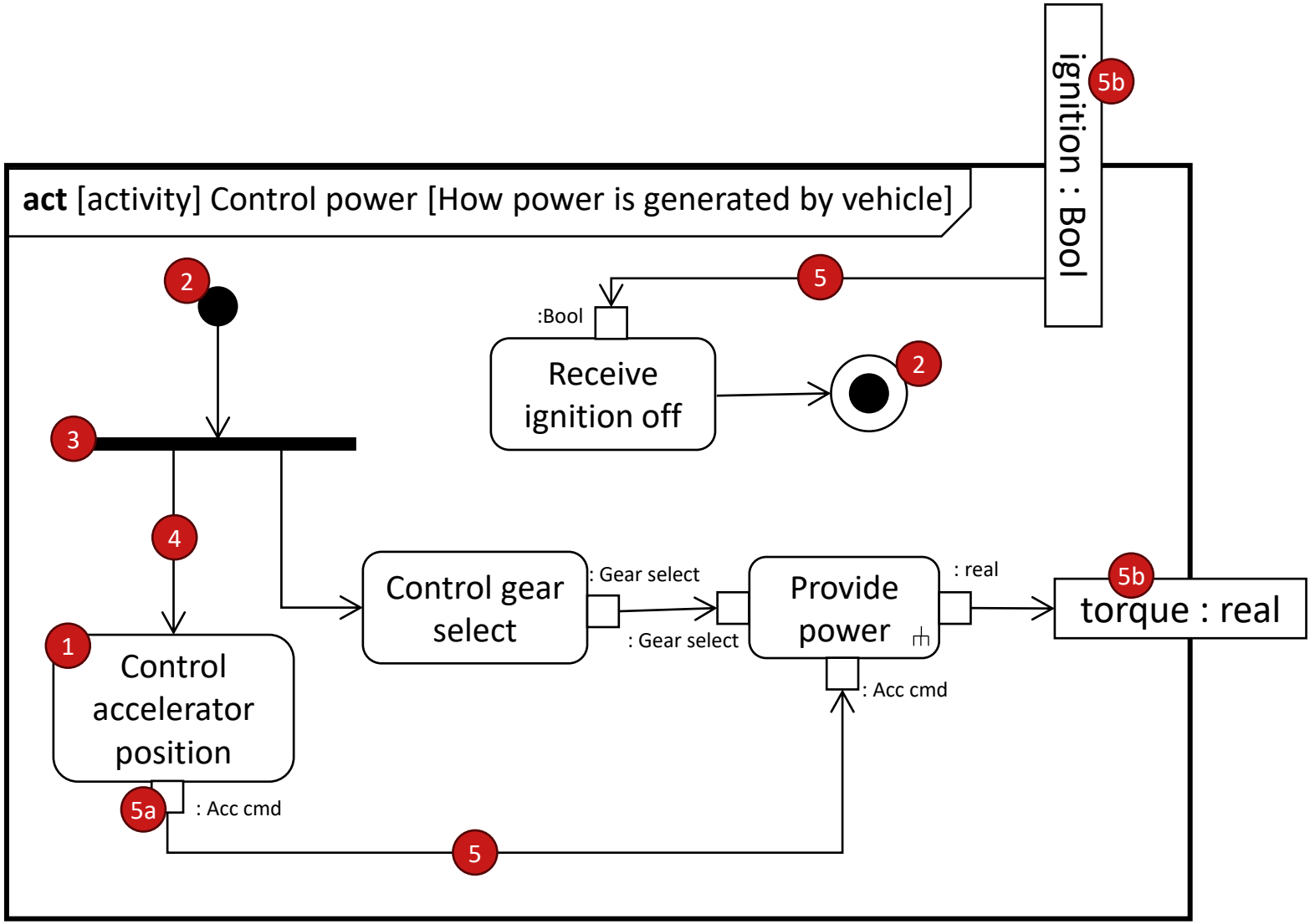
SysML – activities

1. actions
2. control nodes
3. routing nodes

4. control flow
5. object flow
   a. pins
   b. parameters



SysML – activities – model elements

If multiplicities are not shown, then assume 1

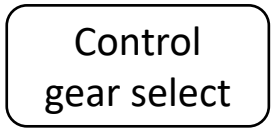
an activity can have

- parameters: direction and multiplicity, has an activity parameter node
- actions: how the activity executes and transforms input to output
  - actions can have input and/or output pins with type and multiplicities for object flows
- object flow
  - tokens model information and/or physical items
  - directed edge between parameters and/or pins of actions
- control flow
  - route control/enabledness
  - directed (dashed) edge between nodes
- routing nodes that modify token streams on both object and control flows
- control nodes for starting and ending control flows and the owning activity

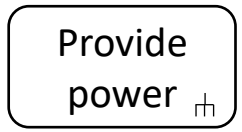
SysML – activities – model elements – actions

types of actions:

- opaque actions (not further decomposed)



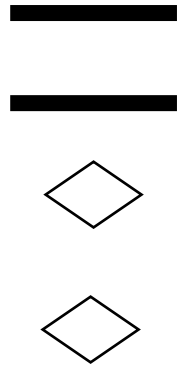
- call-behavior actions (refer to another activity)
  - pin for each parameter of the called behavior (name, type and multiplicity must match)



SysML – activities – model elements – routing/ctrl nodes

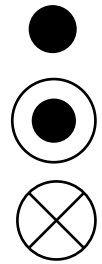
routing nodes that modify token streams on both object and control flows

- fork node: one input, at least one output -> replicates input tokens on output
- join node: at least one input, one output -> produces an output when all inputs have a token
- decision node: one input, at least one output -> input token traverses to one output based on condition
- merge node: at least one input, one output -> each input token is immediately routed to the output



control nodes for starting and ending control flows and the owning activity

- initial node: when activity starts, a control token is placed in each initial node
- activity-final node: termination of activity
- flow-final node: control-token sink

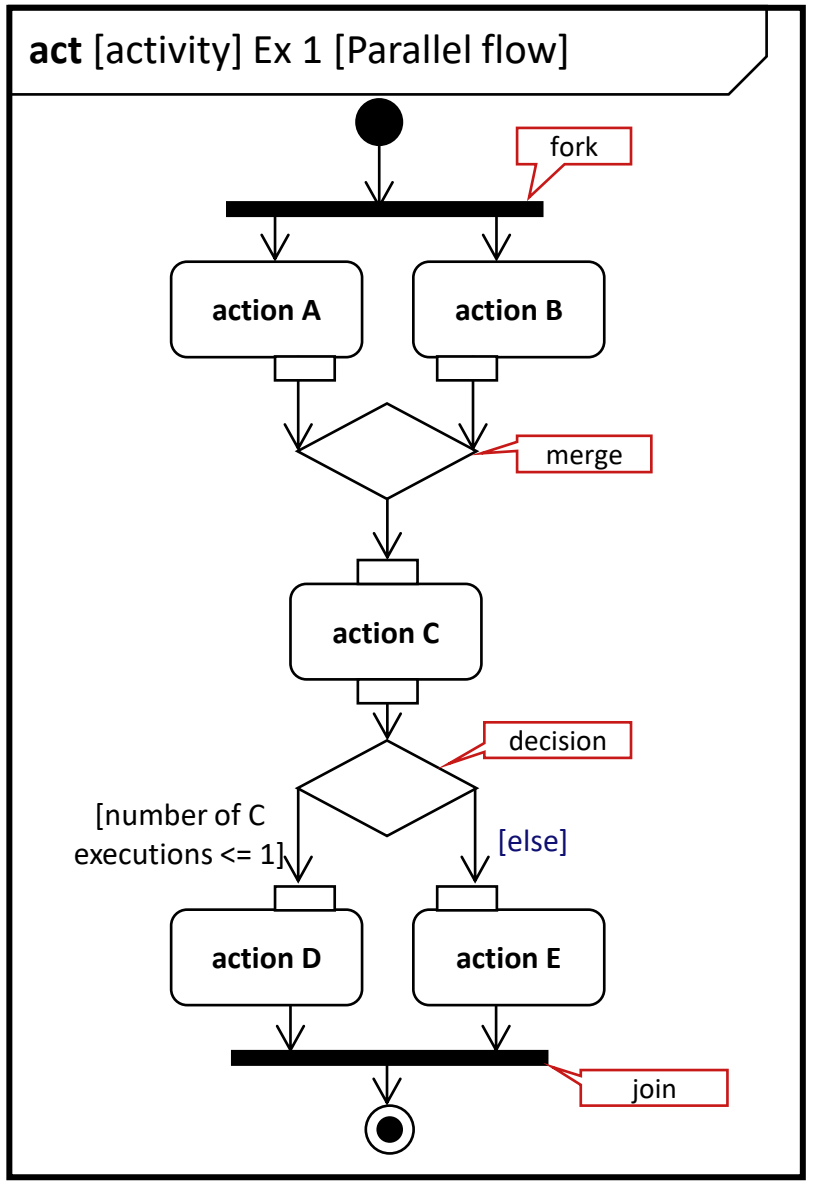


SysML – activities – semantics

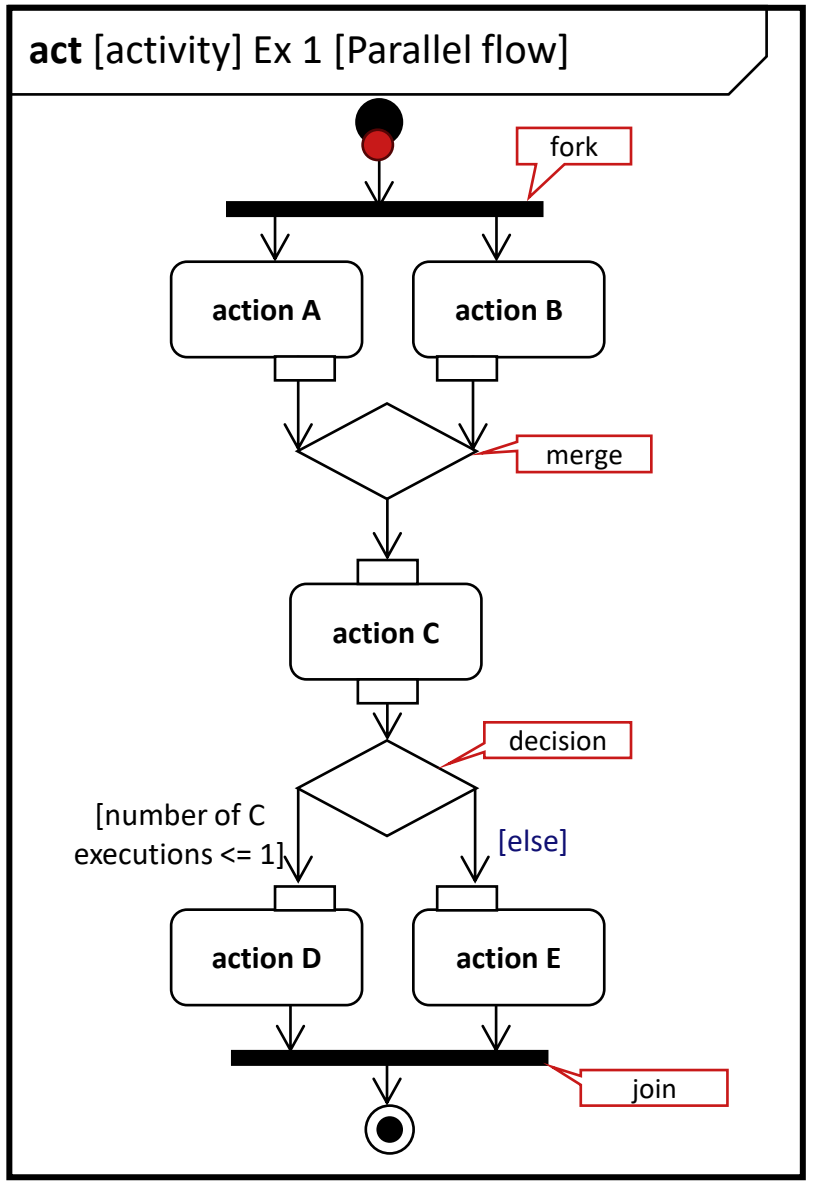
token-flow semantics related to Petri-Nets

- control tokens flow on control-flow edges
- object tokens flow between parameters and/or pins of actions on object-flow edges
  - parameters and pins have a multiplicity and type
  - they can store/buffer object tokens (of the specified type)
- an action can execute if
  - each input pin has at least the minimum required tokens
  - a token is available on each of the incoming control flows
  - these tokens are consumed during execution of the action
- action execution produces tokens
  - one token on each outgoing control flow
  - a number of tokens on each output pin (at least the lower bound of the multiplicity of the pin)

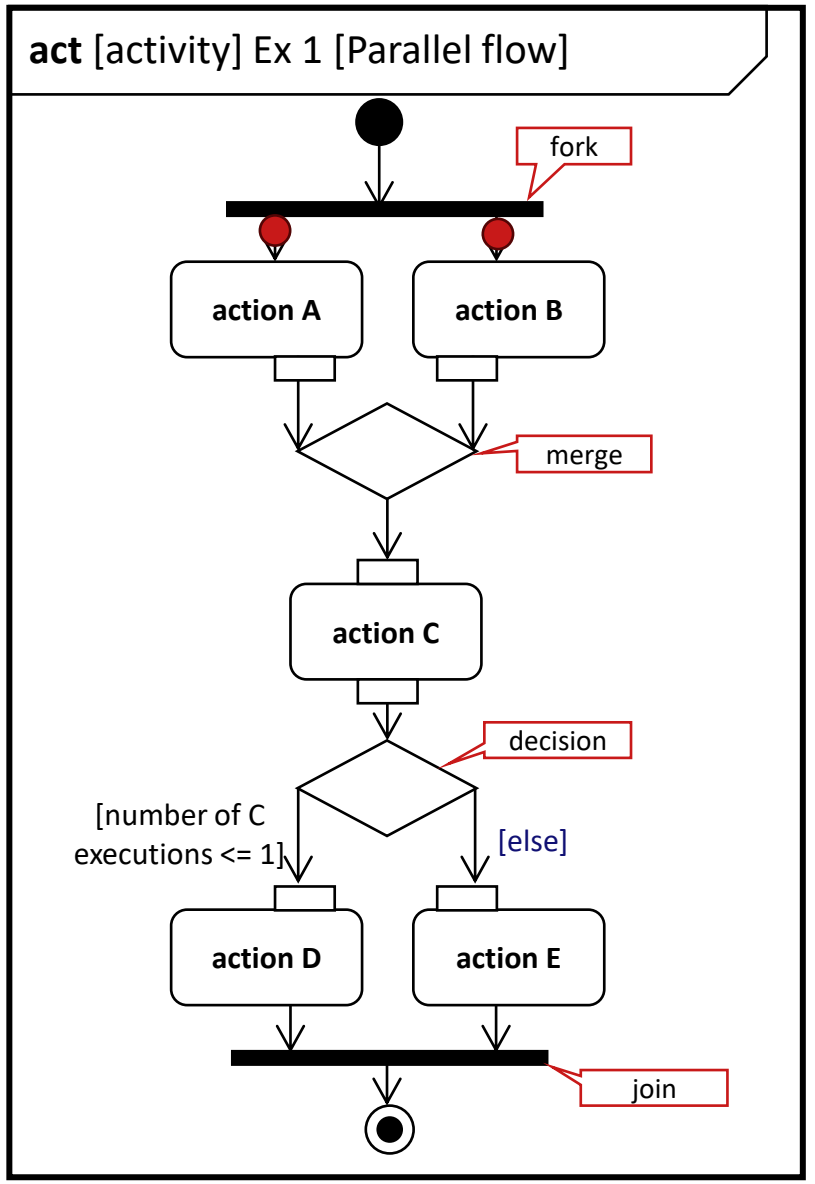
SysML – activities – semantics



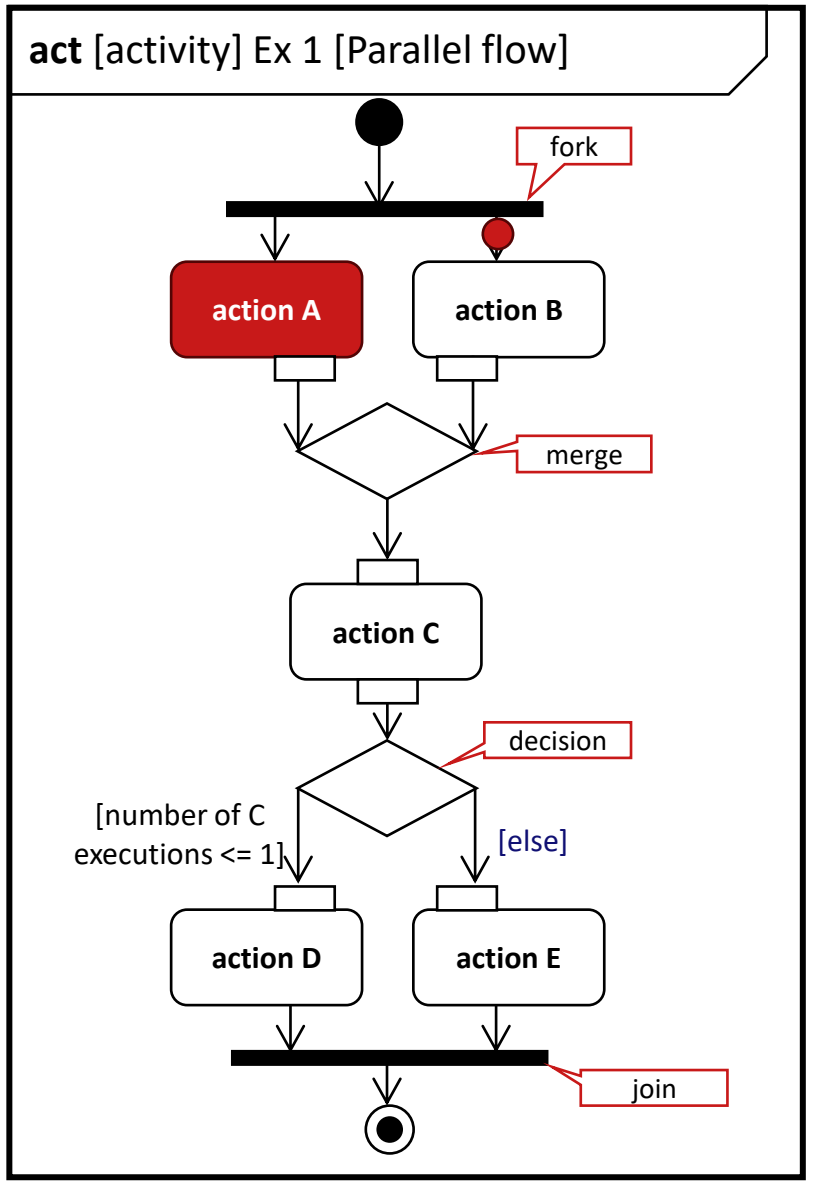
SysML – activities – semantics



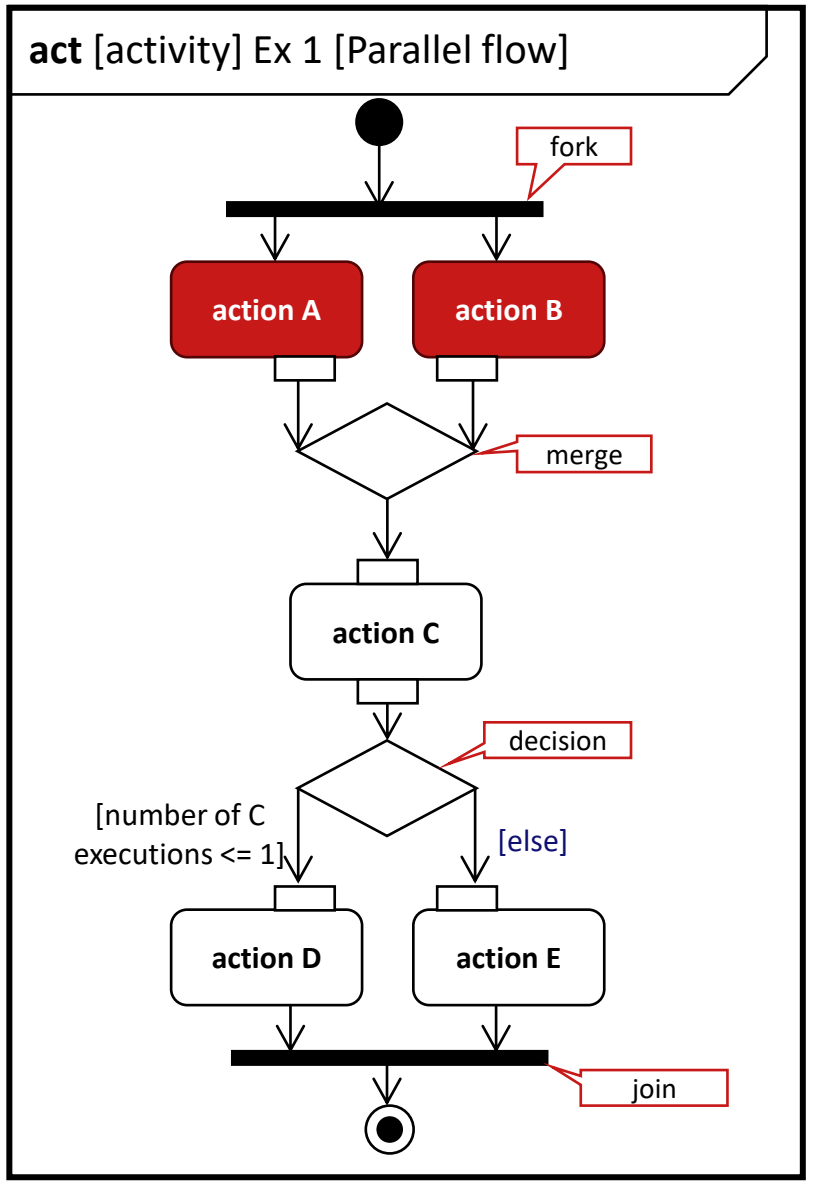
SysML – activities – semantics



SysML – activities – semantics

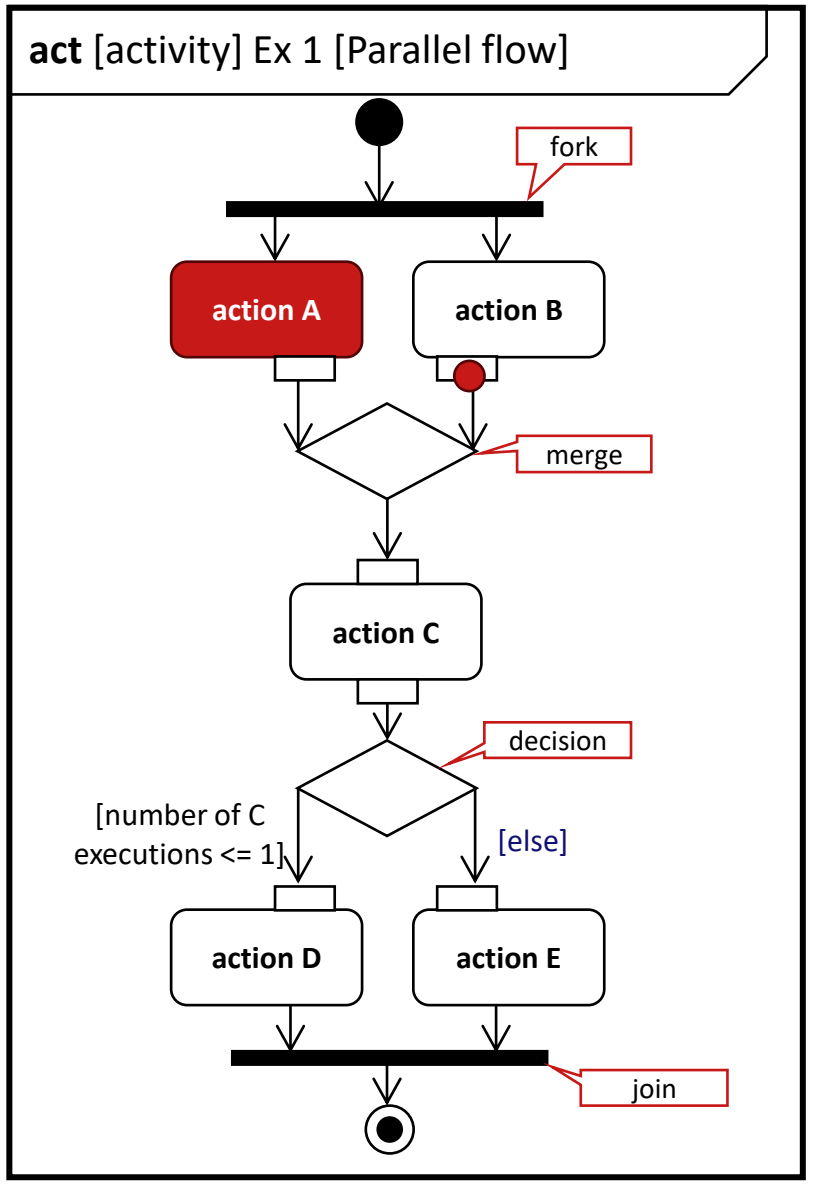


SysML – activities – semantics

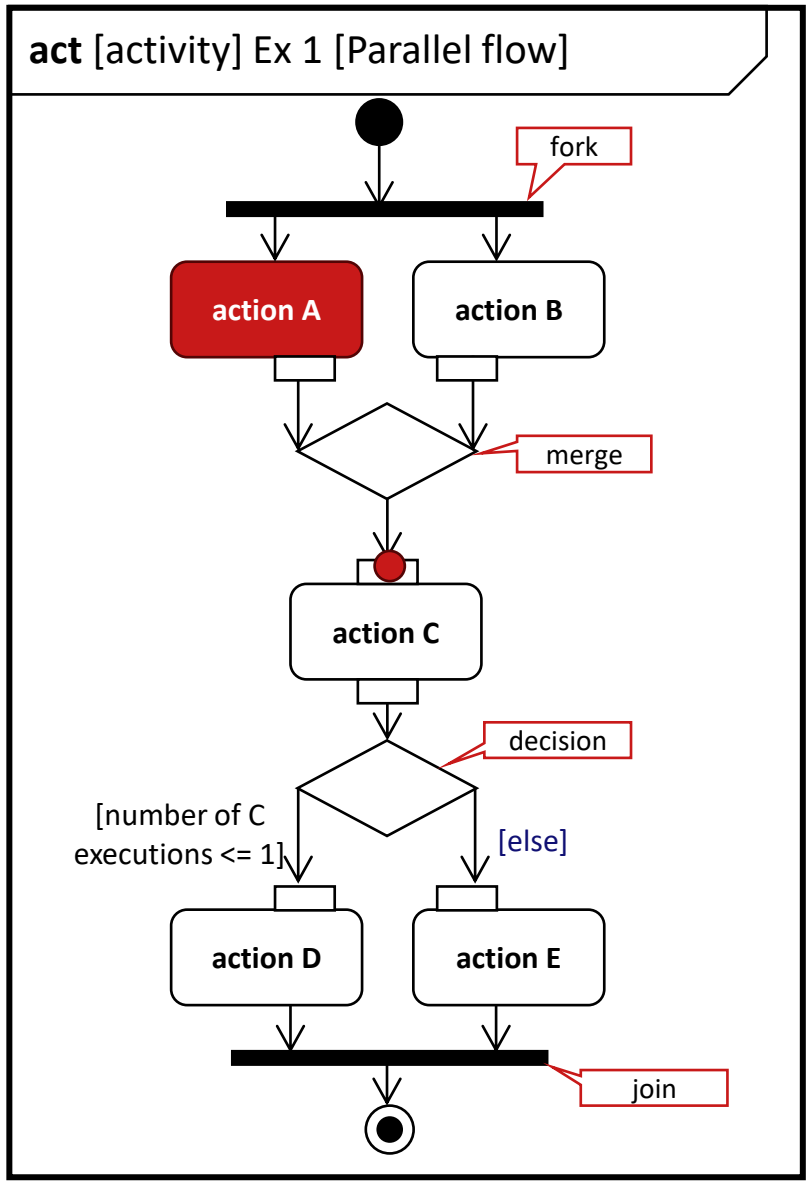


SysML – activities – semantics

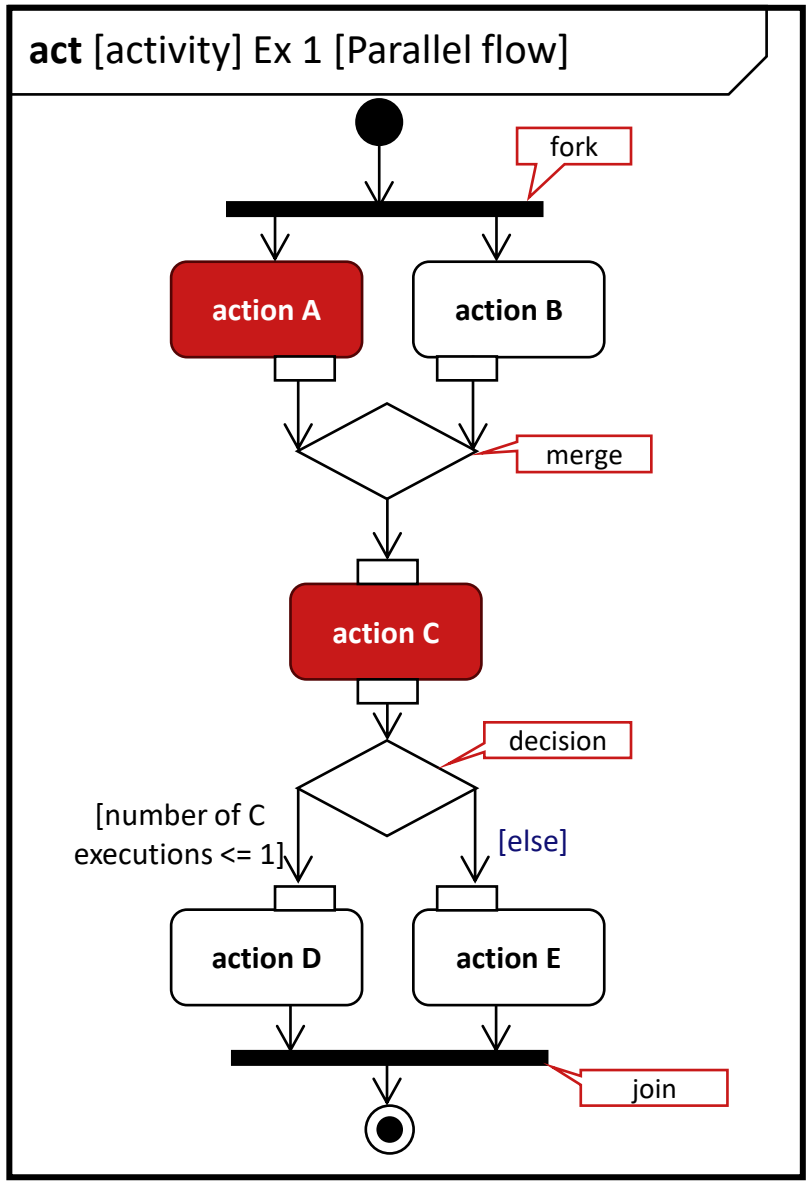
Note that activity diagrams do not have a notion of time. The diagram does, however, specify constraints on the order of events (start and end of actions). A Gantt chart may or may not respect those constraints.



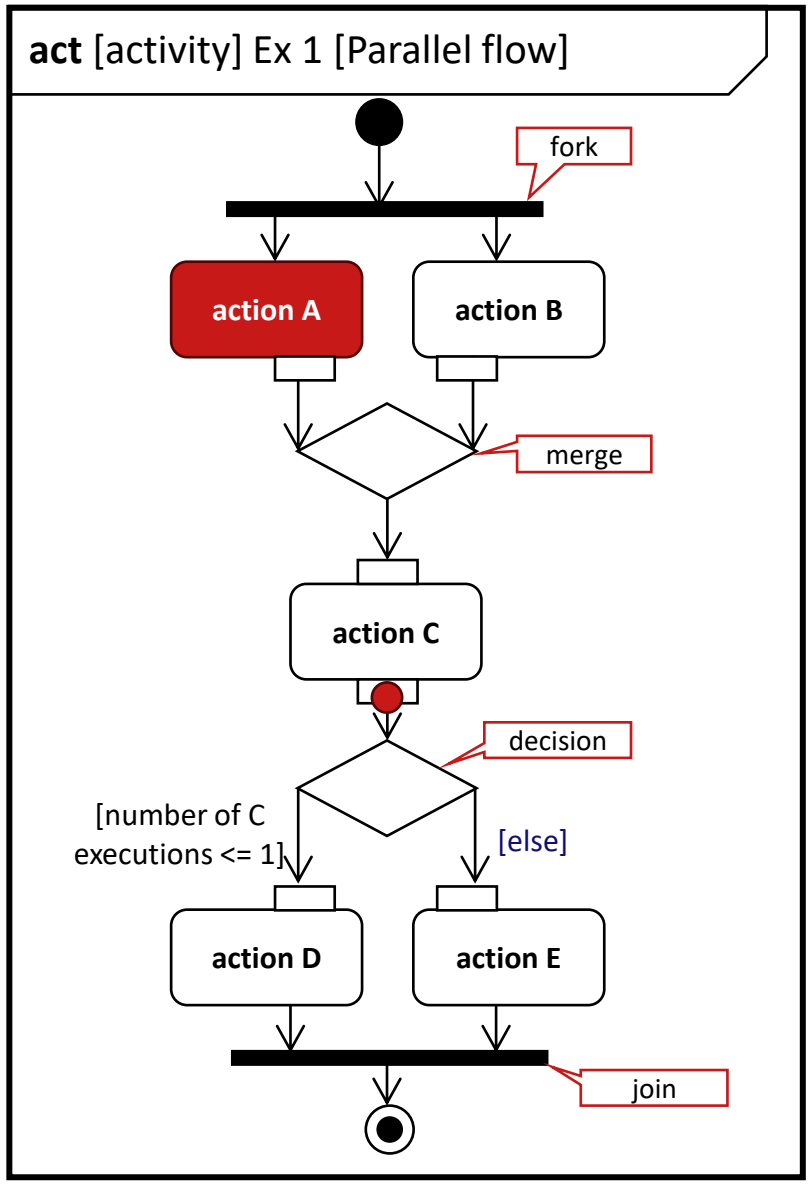
SysML – activities – semantics



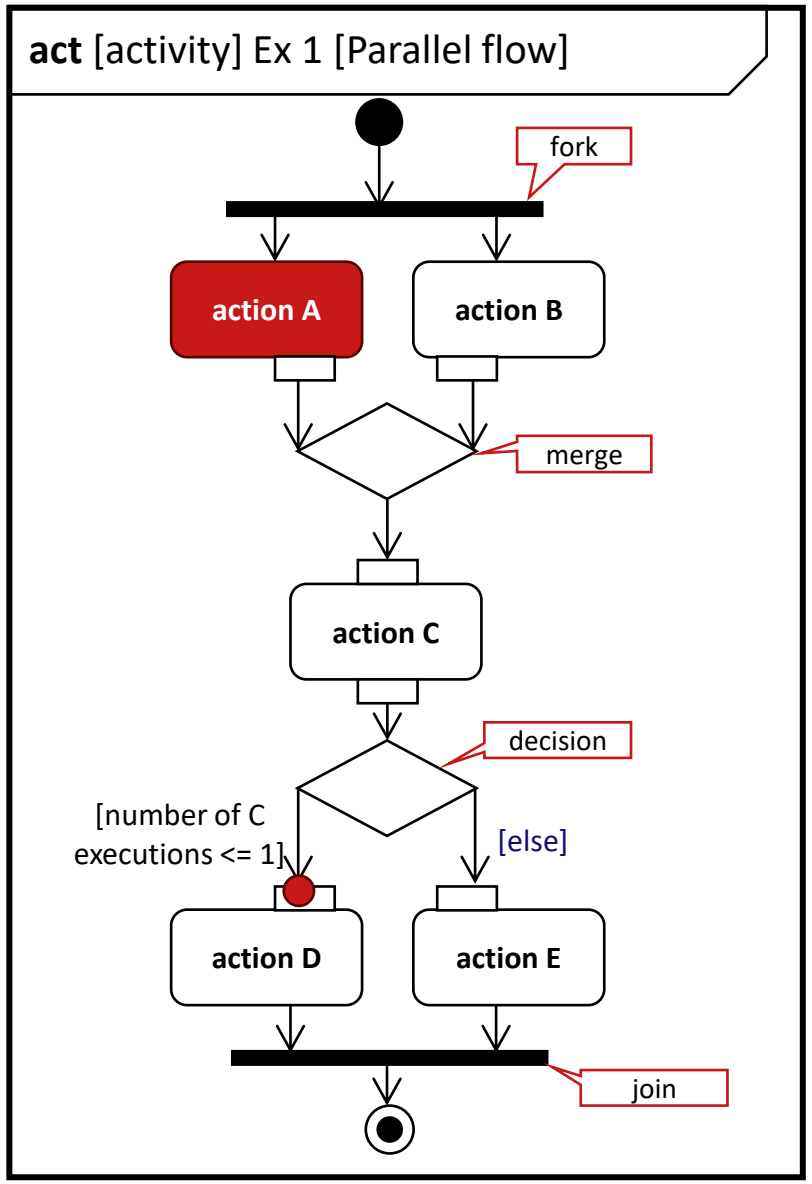
SysML – activities – semantics



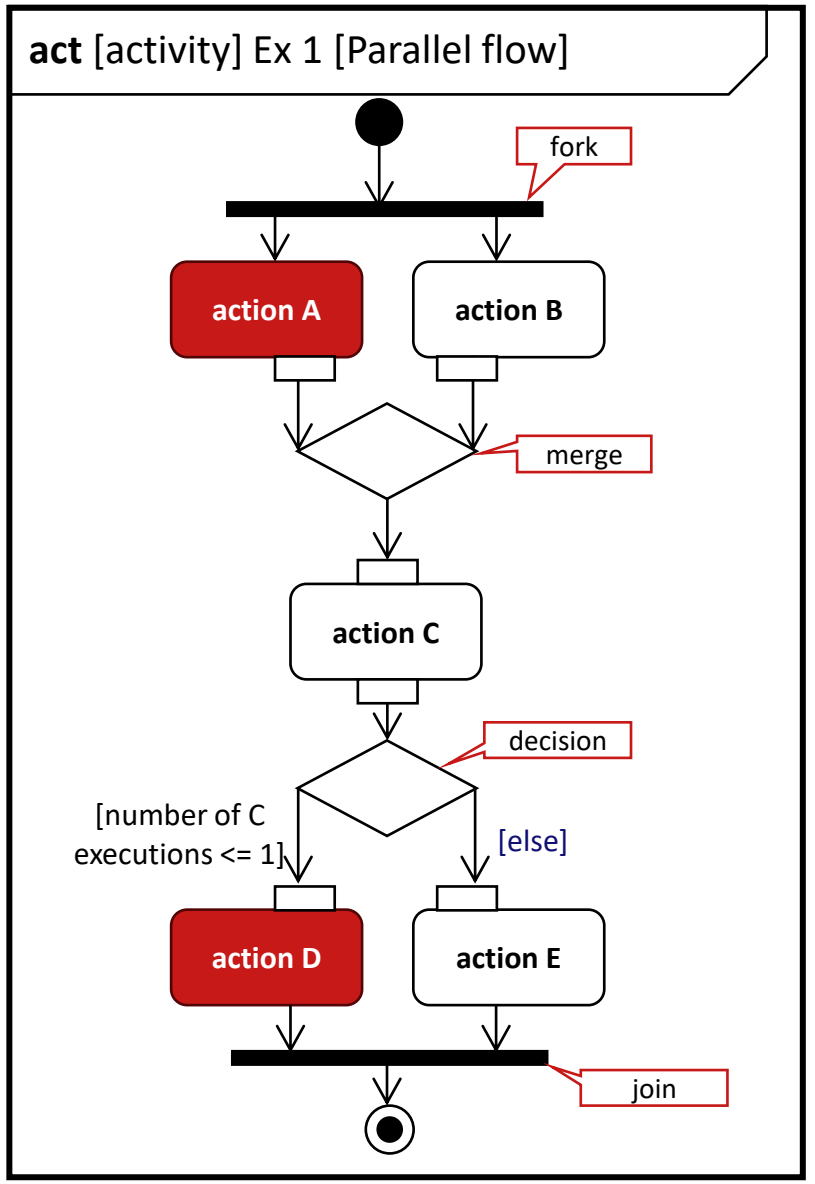
SysML – activities – semantics



SysML – activities – semantics



SysML – activities – semantics



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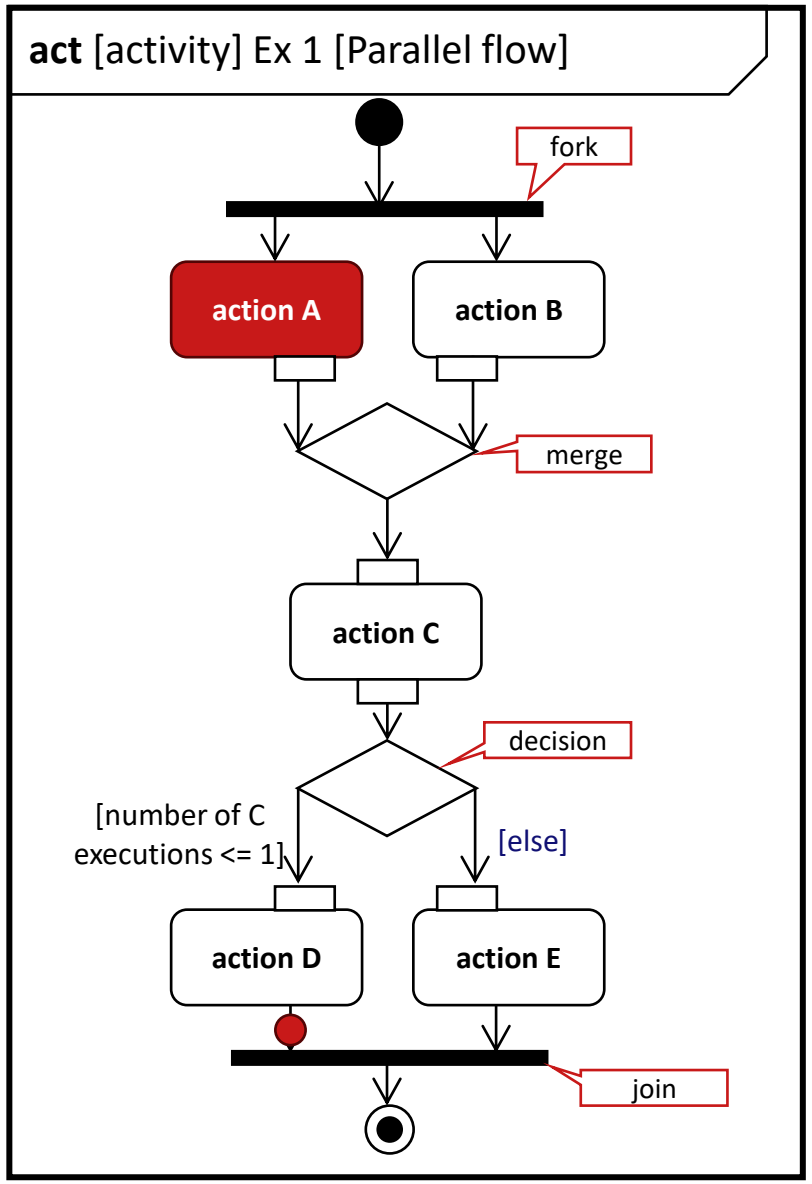

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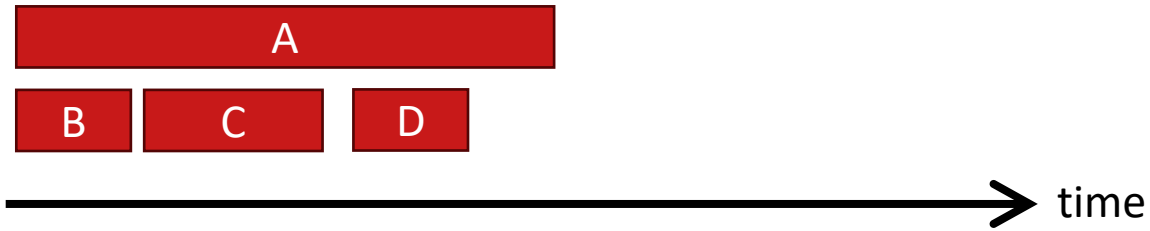

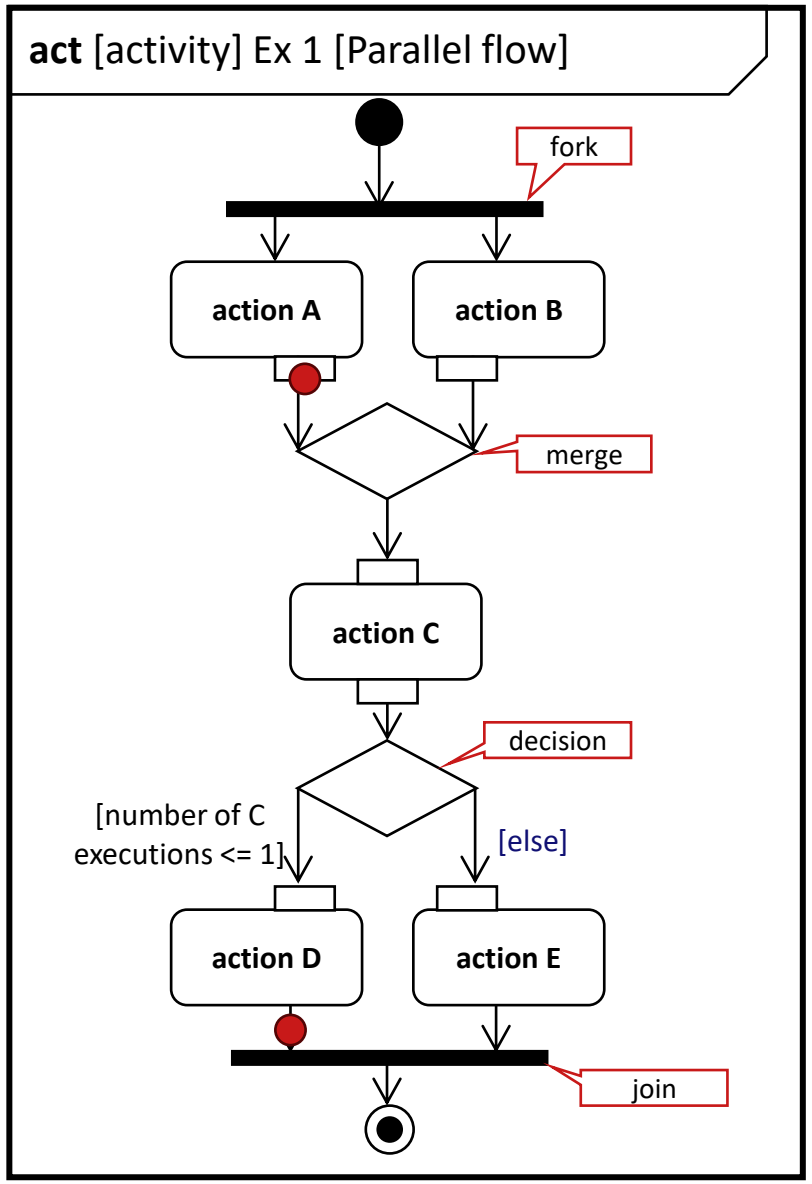

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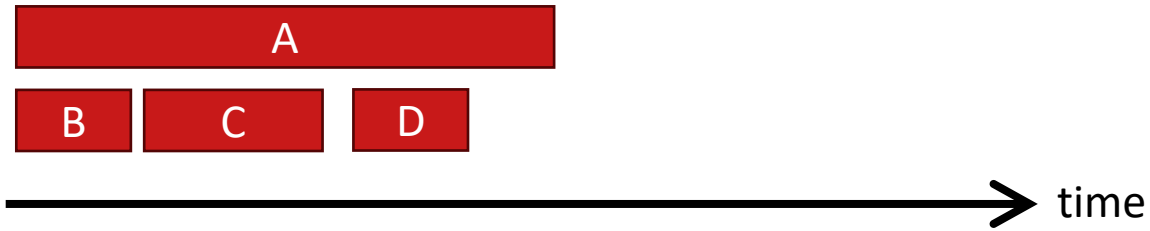

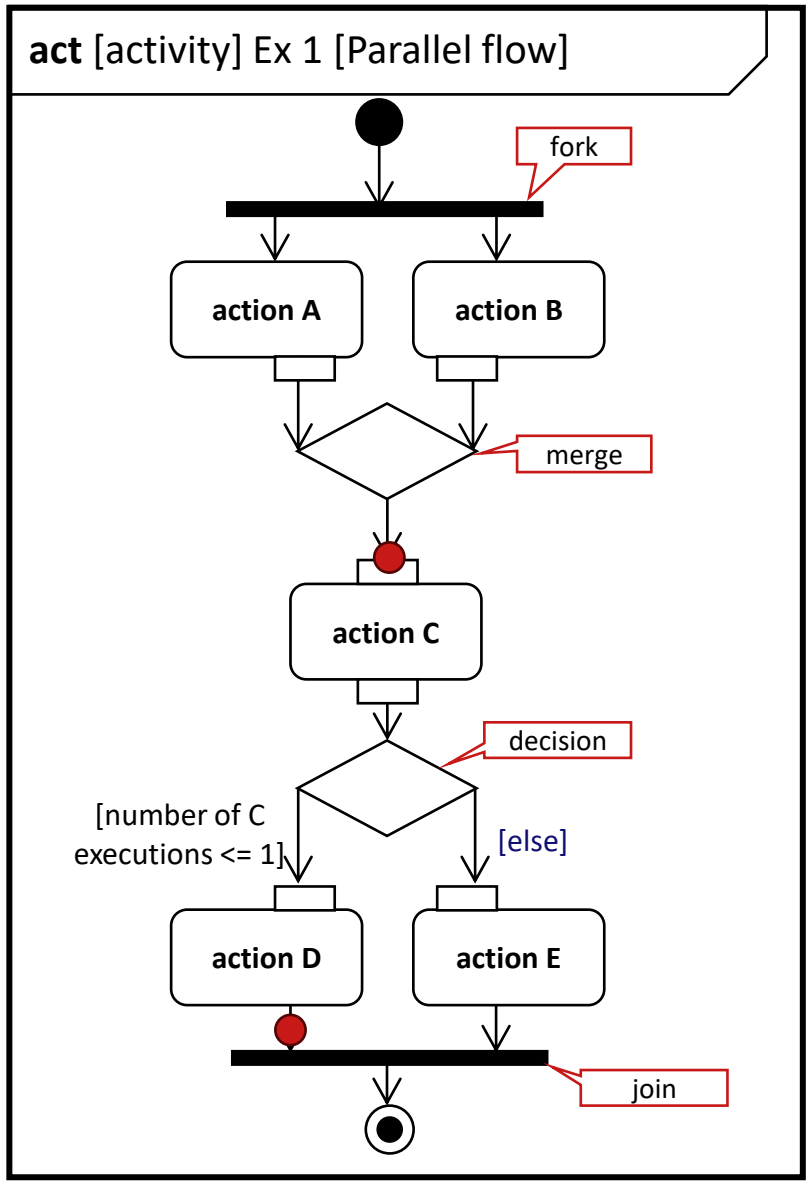

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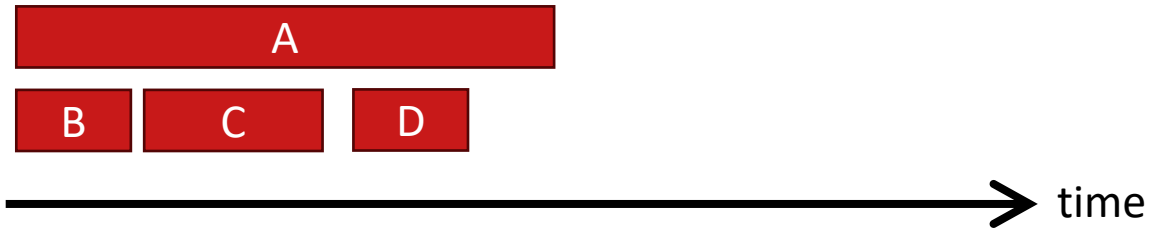

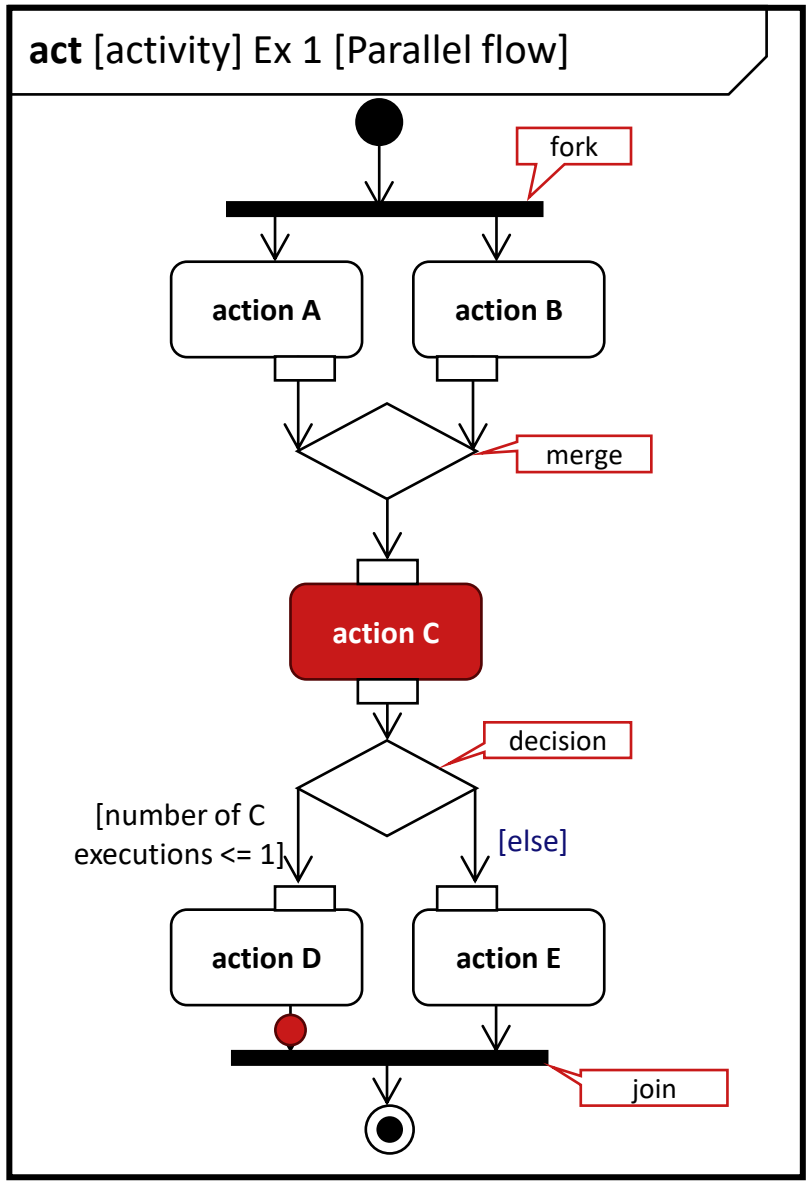

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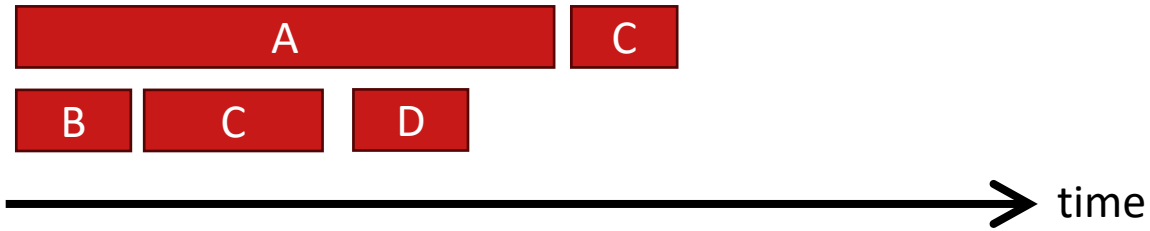

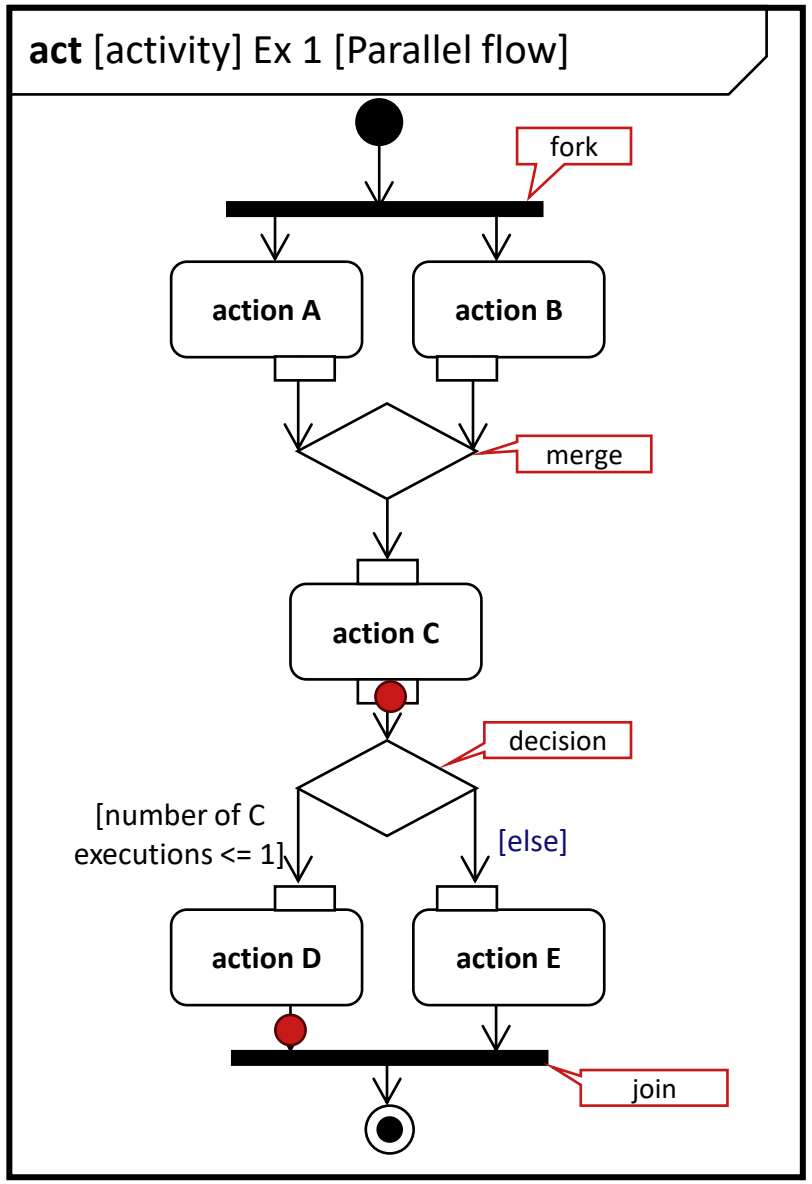

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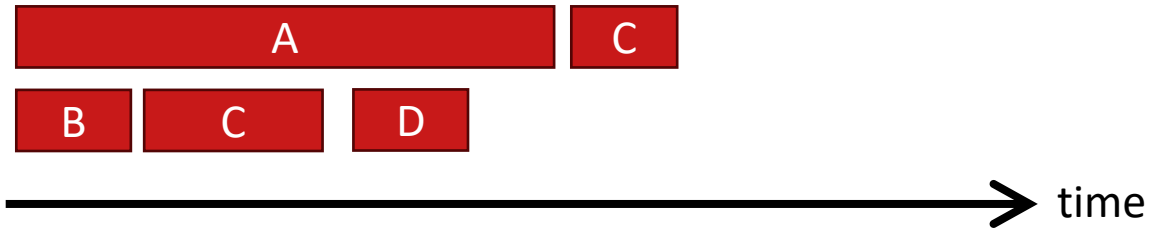

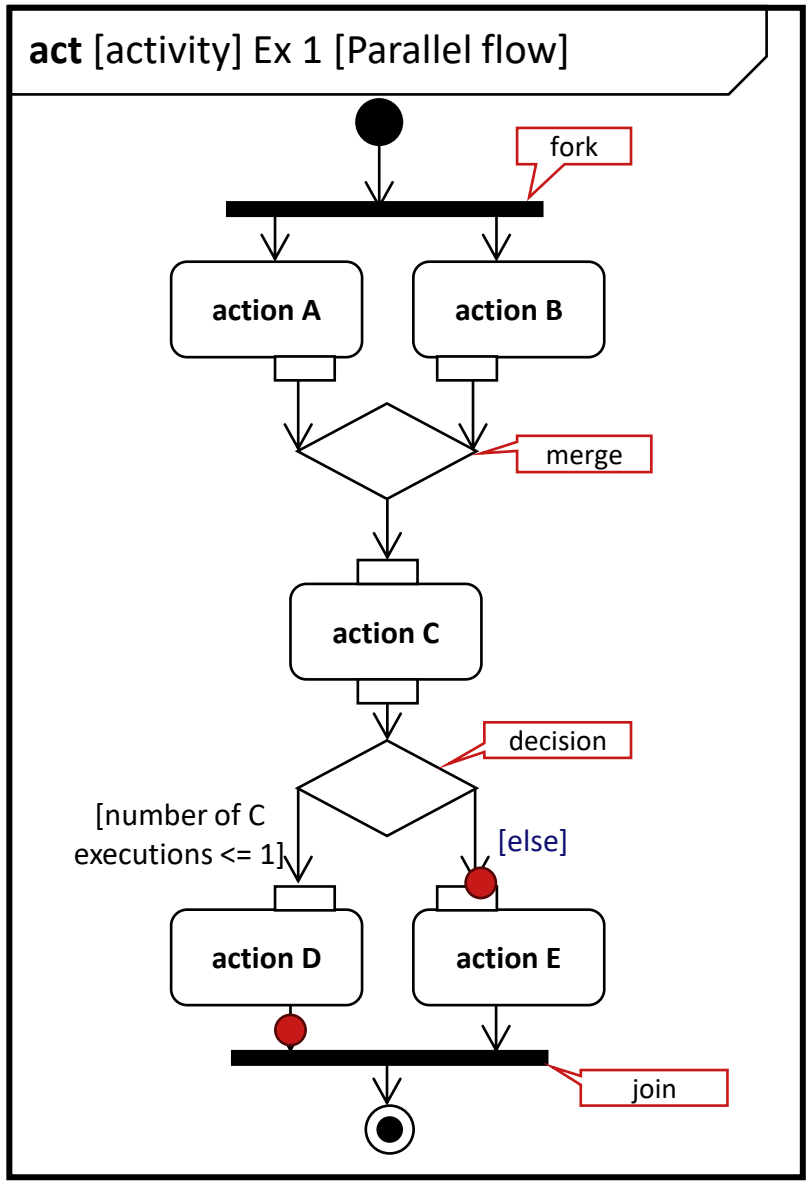

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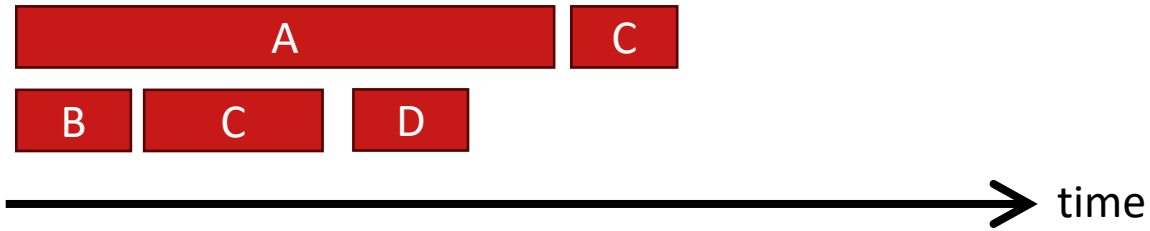

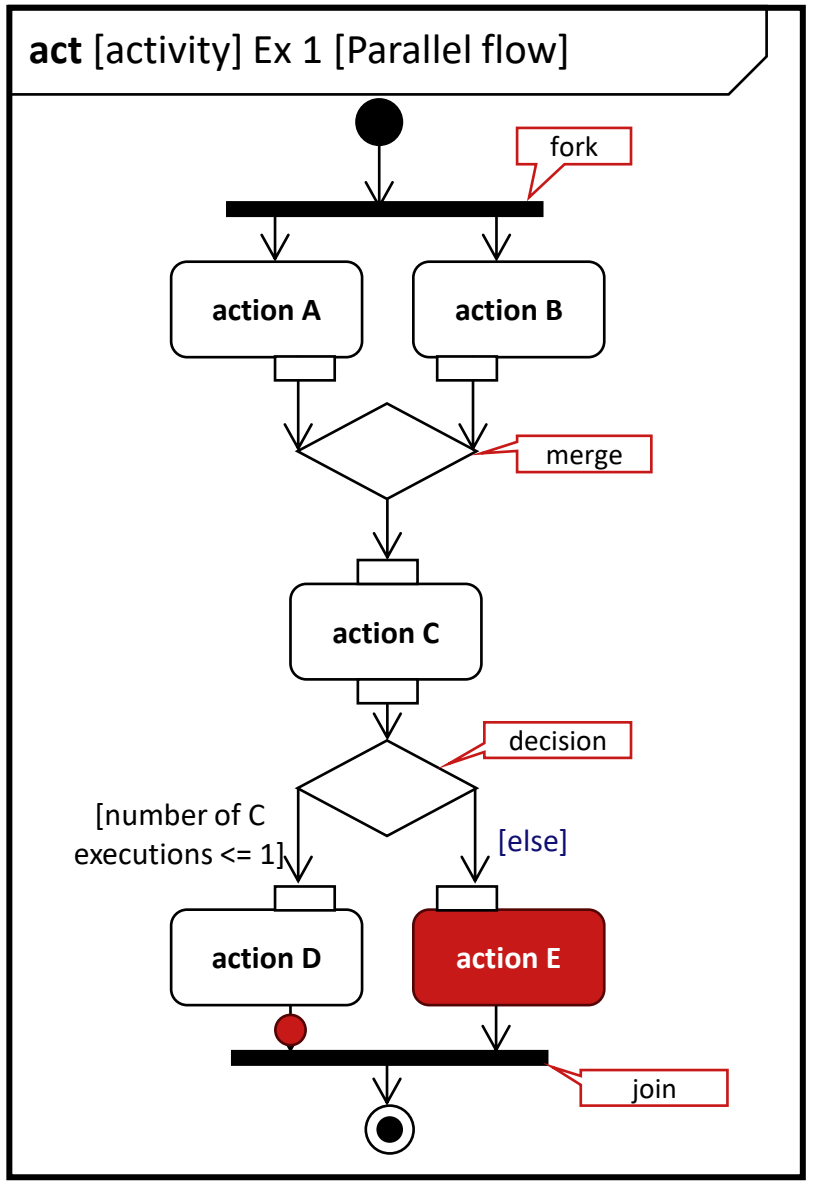

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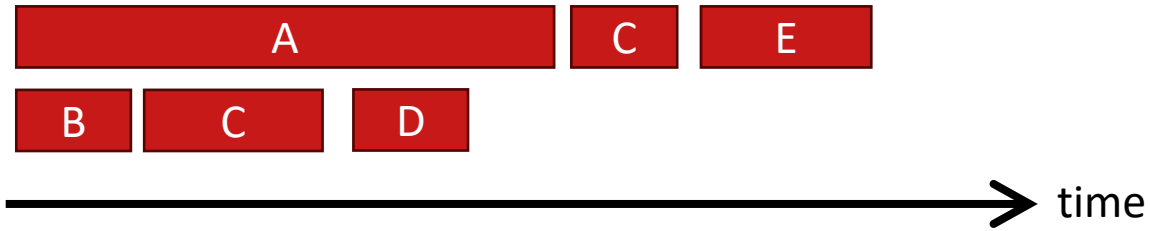
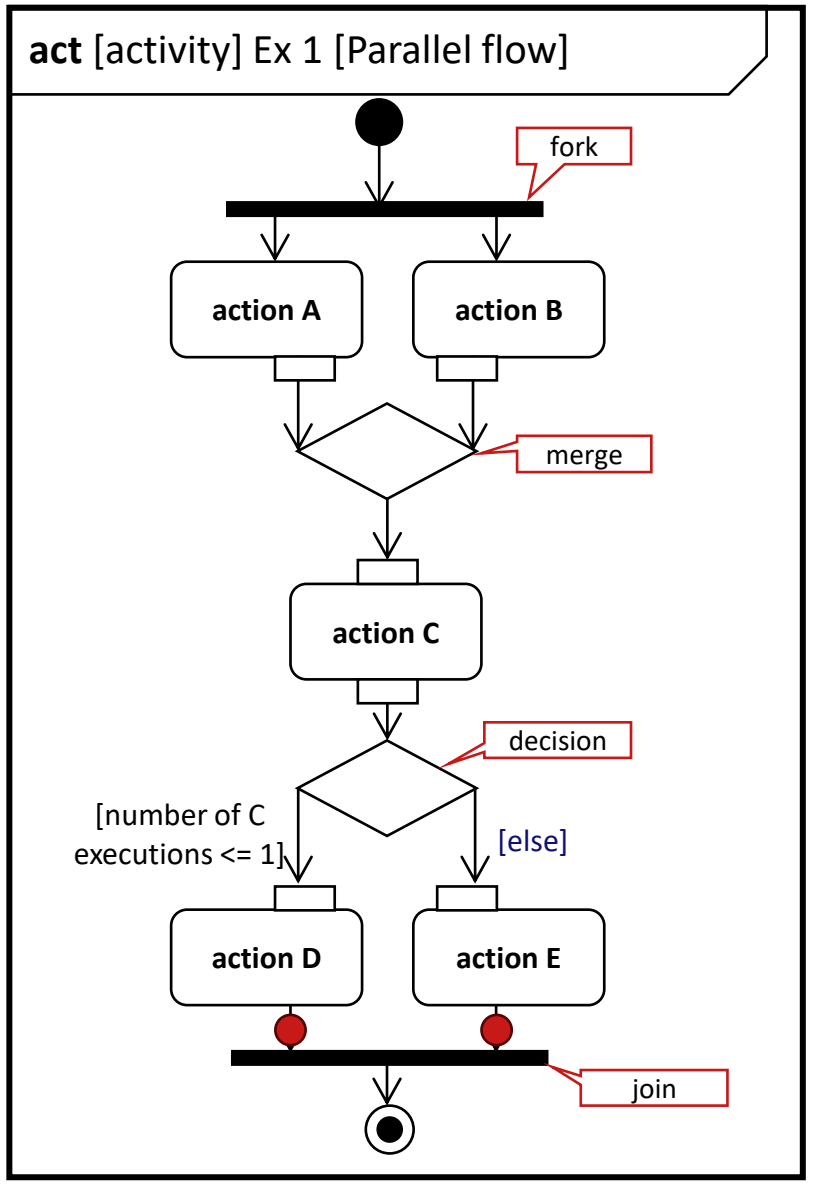
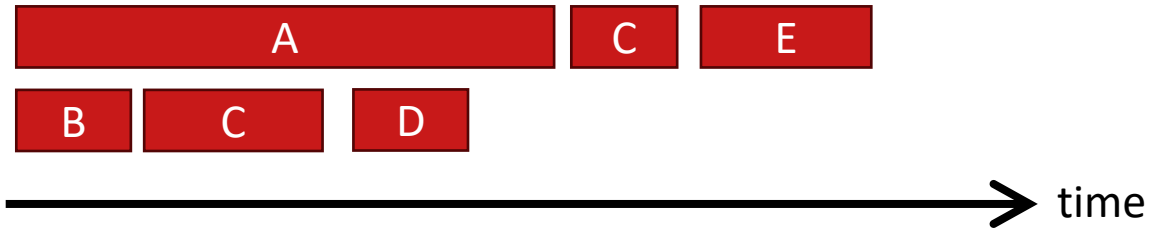
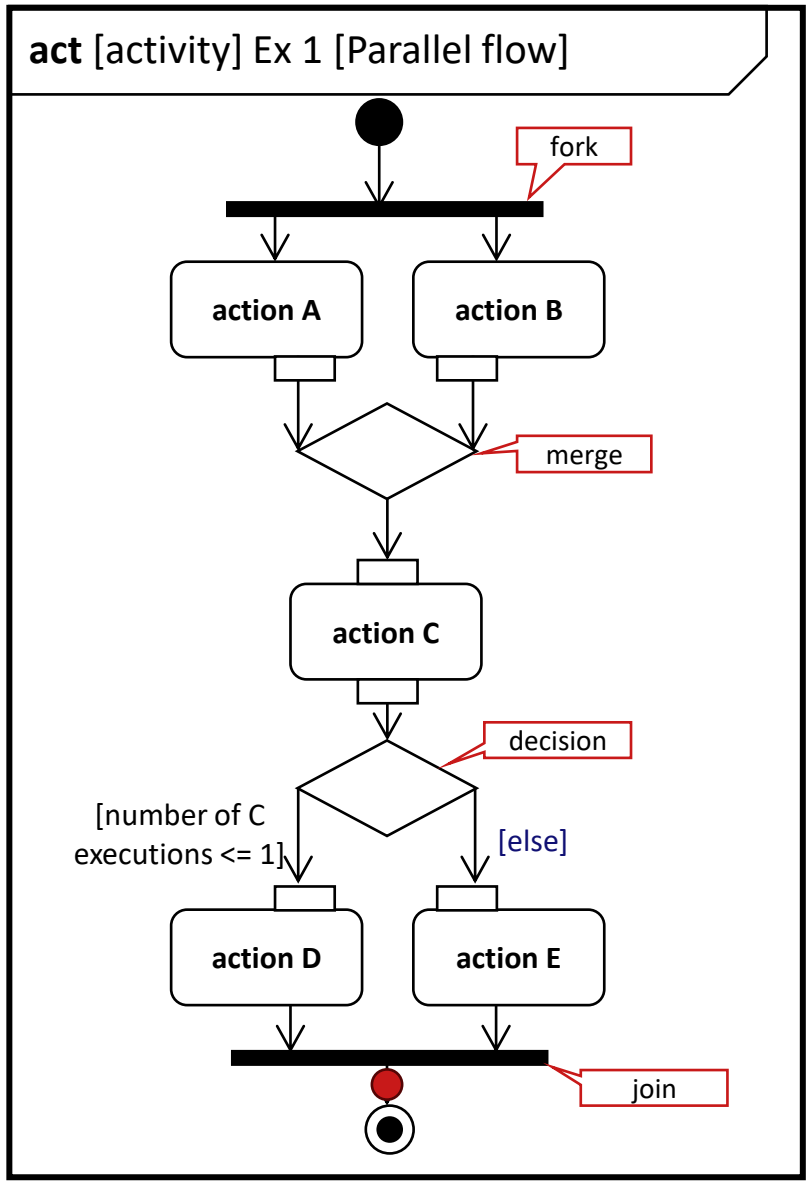


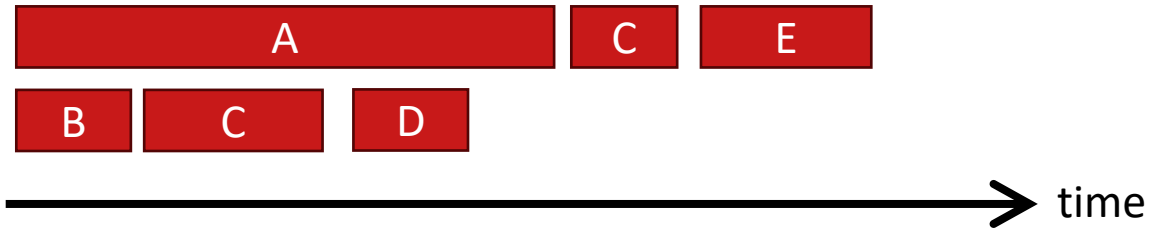


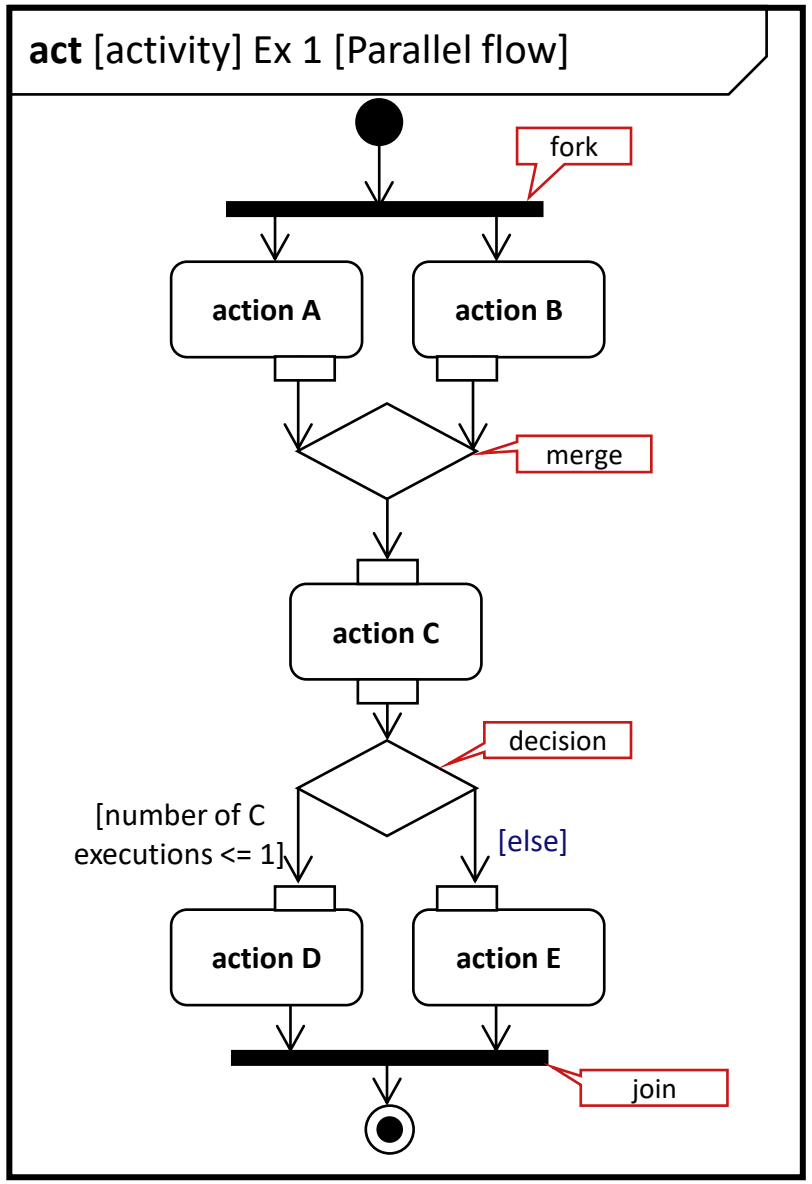
SysML – activities – semantics



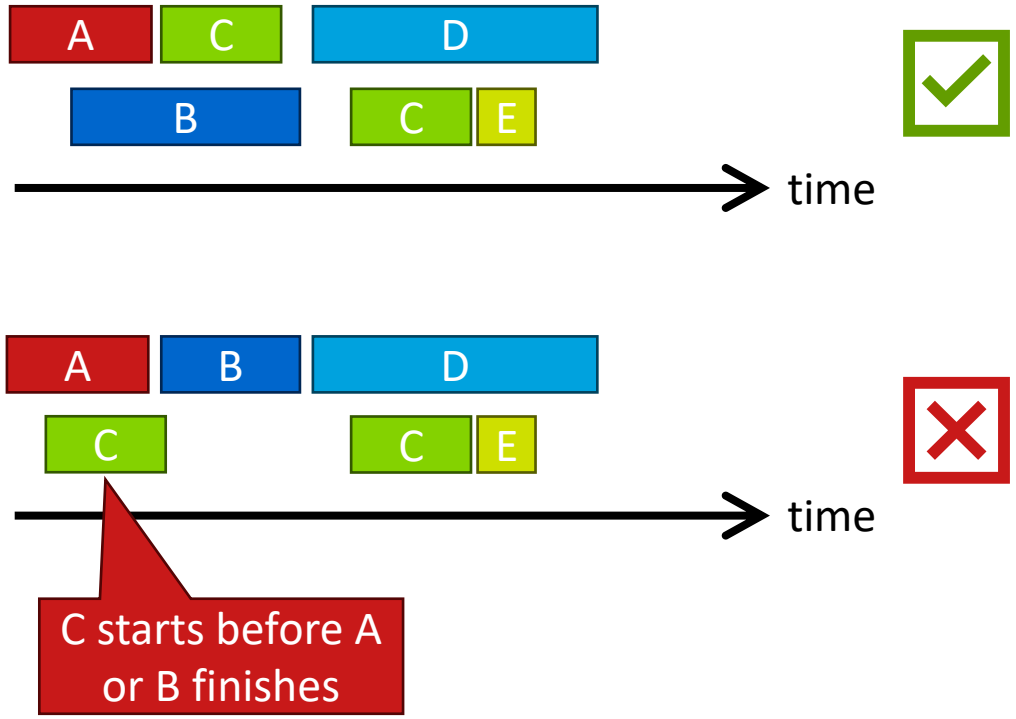


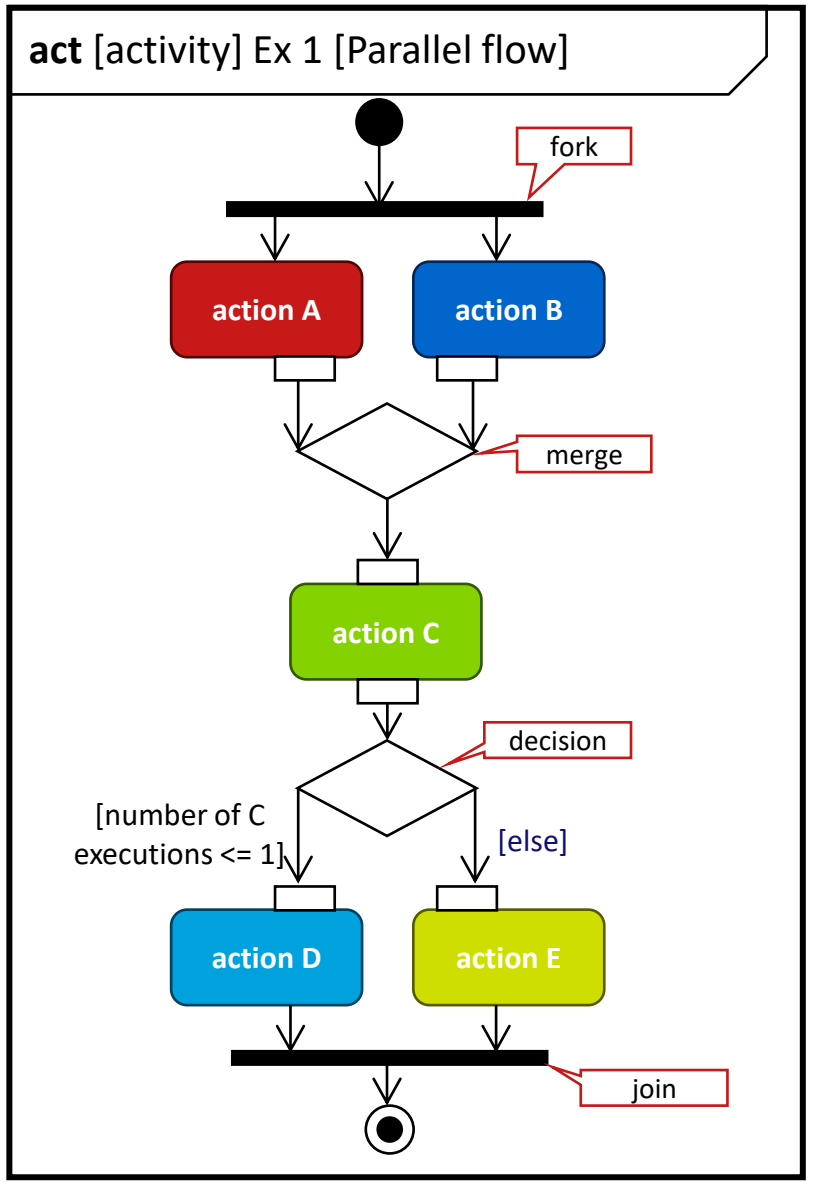
SysML – activities – semantics



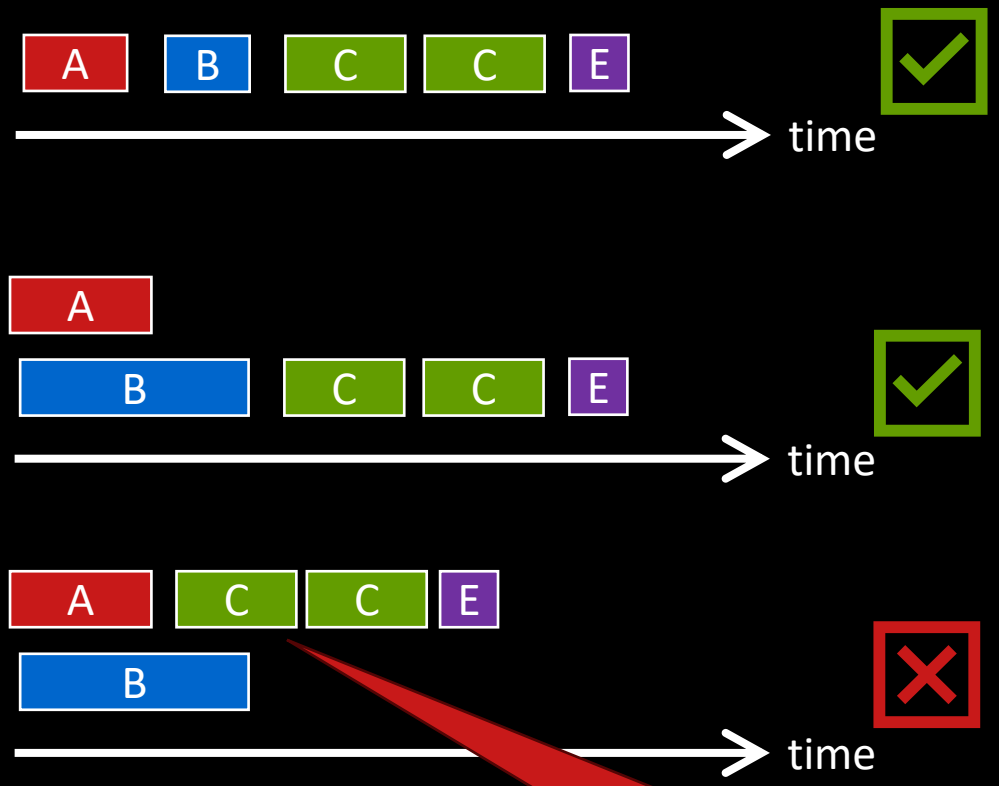


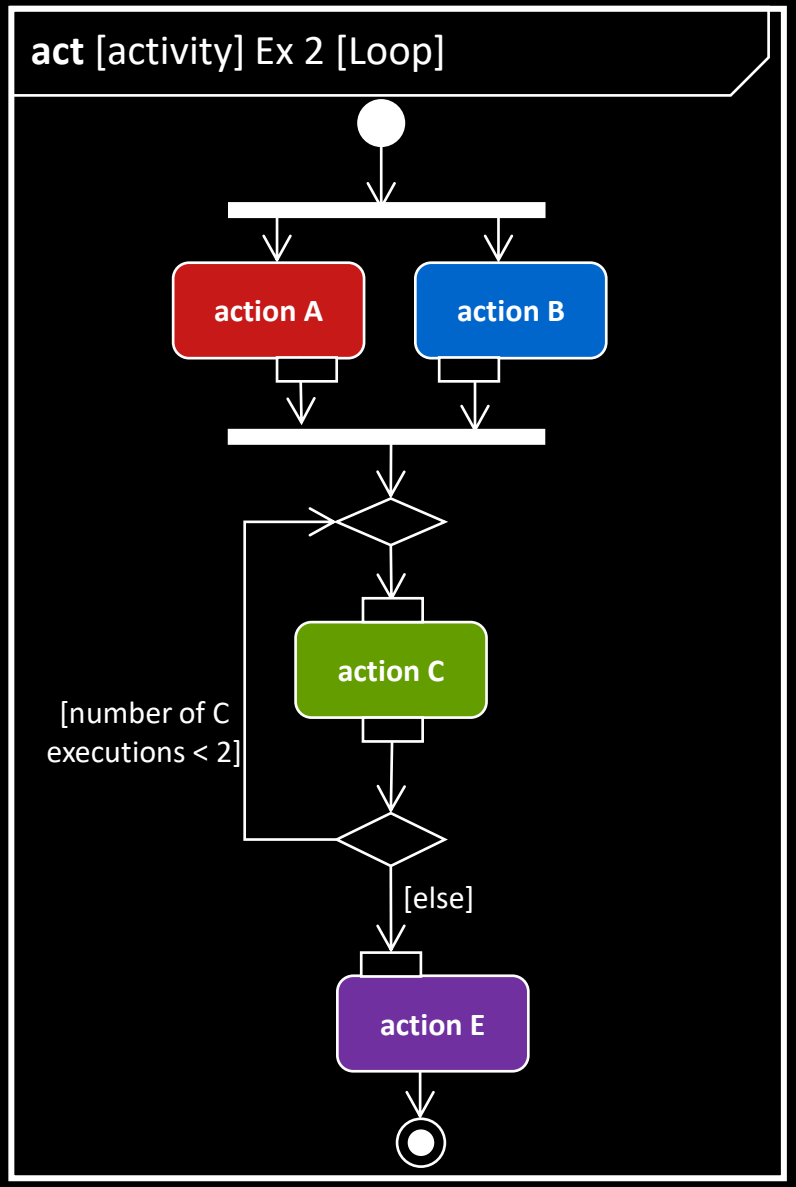
SysML – activities – semantics





think – pair – share



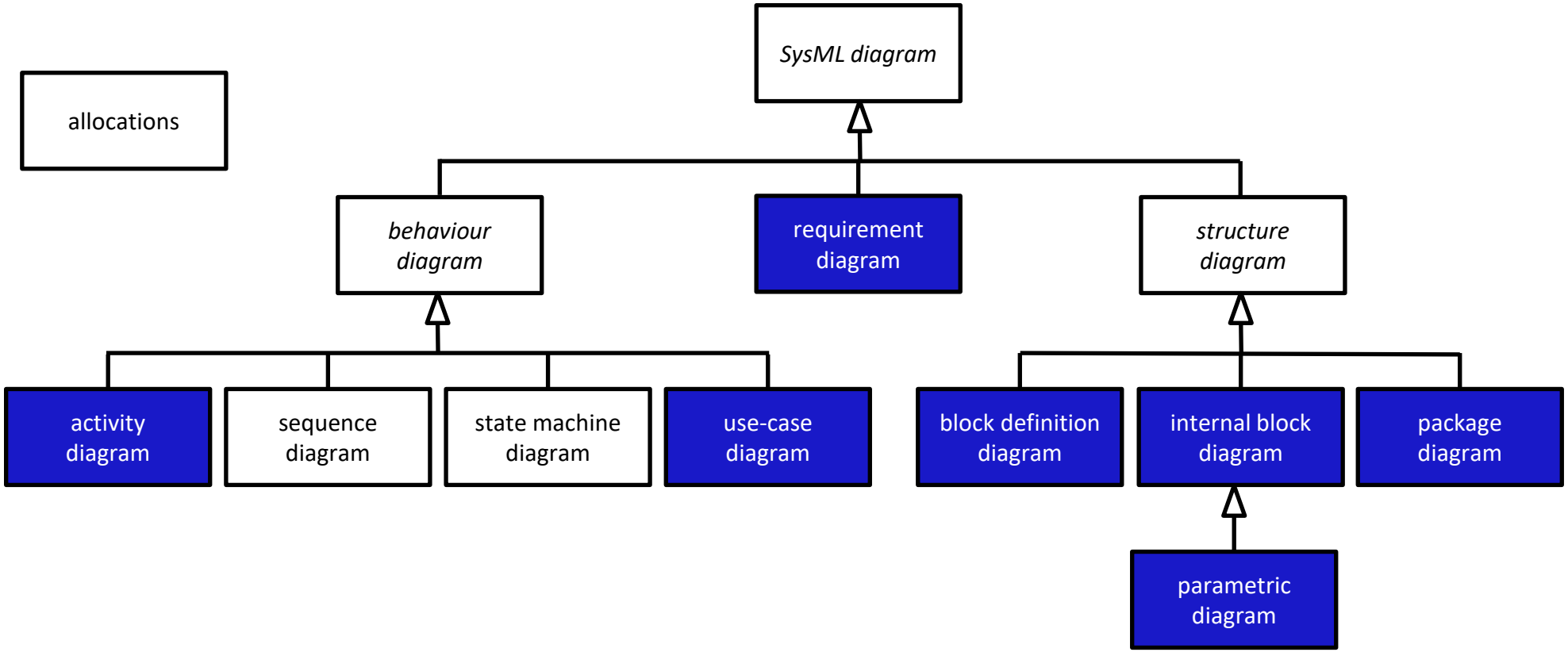


SysML – activities – suggested reading

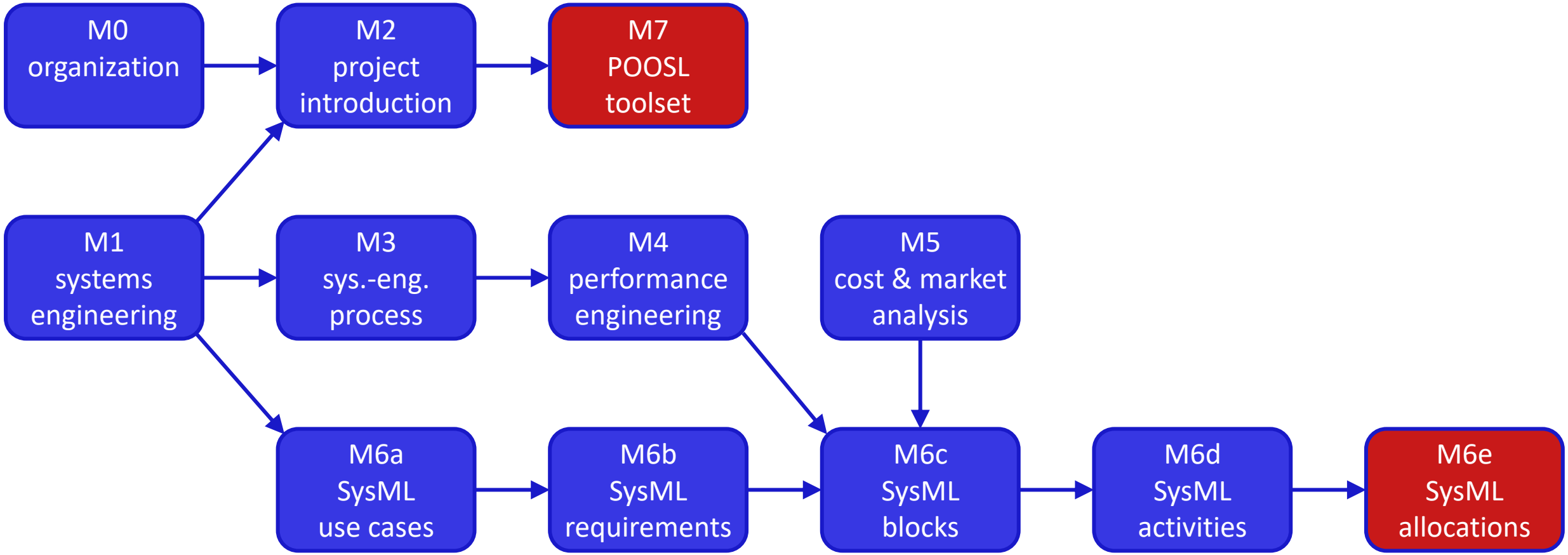
- 9.1, 9.2, 9.3, 9.4, 9.5.1, 9.6.1

SysML – diagram overview

diagrams are **views** on the model
(i.e., on a subset of model elements)



modules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organization
M2
project
introduction
M7
POOSL
toolset
M1
systems
engineering
M3
sys.-eng.
process
M4
performance
engineering
M5
cost & market
analysis
M6a
SysML
use cases
M6b
SysML
requirements
M6c
SysML
blocks
M6d
SysML
activities
M6e
SysML
allocations

to remember

activities model dynamic behavior with actions; can be used to refine use cases

- input/output parameters
- sequential/parallel and conditional execution of actions

activities can be re-used as actions in other activities: decomposition

- parameters of called activity must match the pins of the action

token-flow semantics based on Petri-nets